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of the

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Proceedings and Papers

of the

Standardization Committees

of the

American Mining Congress

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INTRODUCTION

The following pages carry a report of the chairmen of the Standardization Division to the 23rd Annual Convention of the American Mining Congress held at Denver, Colo., November 15 to 20, 1920.

At this meeting, comprehensive recommendations were made through the general chairmen: Col. Warren R. Roberts, president, Roberts & Scheafer Company, Chicago, Illinois, chairman of the coal mining branch, and Charles A. Mitke, consulting engineer, Bisbee, Arizona, chairman of the metal branch.

The purpose of the publication of this bulletin is that the widest publicity may be given to the activities of this division. The bulletin will be mailed to a large number of mining operators, consulting engineers, manufacturers, and others interested in the mining industry.

In the two years in which the work of this division has been carried on, unusual interest has been manifest among operators, engineers and manufacturers, and we are anxious to receive from them suggestions as to how the committee can improve its work; suggestions for enlarging the scope of the work of both the coal and metal branches. Criticisms of the recommendations already made are solicited and will be given careful consideration. These communications should be addressed to Standardization Division, The American Mining Congress, 841 Munsey Building, Washington, D. C. These communications will be sent to the chairman of the sub-committees whose work is under discussion, and in this way we will be able to eliminate matters that do not meet with the approval of the industry and we hope to receive helpful suggestions which will advance the work of this division in the most intelligent and helpful manner.

Respectfully submitted,

THE AMERICAN MINING CONGRESS,

J. F. Callbreath, Secretary.

STANDARDIZATION MINING EQUIPMENT

Metal and Coal Branches

COAL BRANCH

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Professor John W. Hallock, Head of Dept. of Industrial Engineering, University of Pittsburgh, Pittsburgh, Pa.
R. Y. Wert, Mine Drainage Supt., Durham Coal & Iron Co., Soddy, Tenn.
J. H. Edwards, Electrical Engr., Enkhorn Piney Coal Mining Co., Huntington, W. Va.
L. D. Tracy, Mining Engineer U. S. Bureau of Mines, Pittsburgh, Pa.

Ventilation

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Warren R. Roberts, Wrigley Building, Chicago, Ill.
Rudolph H. Kudlich, Asst. to Chief Mechanical Engr., U. S. Bureau of Mines, Washington, D. C.

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R. L. Kingsland, General Superintendent, P. & M. Dept., Cons. Coal Co., Fairmount, W. Va.
Carl Lee, Electrical Engineer, Peabody Coal Co., McCormick Building, Chicago, Ill.
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C. D. Woodward, Chief Electrical Engineer Anaconda Copper Mining Co., Butte, Mont.

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G. F. Osler, Carnegie Coal Co., Pittsburgh, Pa.—Representing Outside Coal Handling Equipment.

METAL BRANCH

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Ocha Potter, Superintendent, Superior Division, Calumet and Hecla Mining Co., Houghton, Mich.
R. T. Murrill, Inspiration Cons. Copper Co., Inspiration, Ariz.

George H. Gilman, 125 Prescott Street, East Boston, Mass.
Charles Lees, Superintendent, Iron Cap Copper Co., Copper Hill, Ariz.
Charles A. Smith, Mine Superintendent, Ray Cons. Copper Co., Ray, Ariz.
Roy Marks, Stope Engineer, Box 1676, United Verde Exten. Mining Co., Jerome, Ariz.
Earl Hastings, Foreman, Clay Mine, Arizona Copper Co., Ltd., Morenci, Arizona.
Frank Ayer, Mine Superintendent, Moctezuma Copper Co., Pilares De Nacozari, Sonora, Mexico.
W. G. Scott, Superintendent, Coronado Mines, Arizona Copper Co., Ltd., Metcalf, Ariz.
Thos. C. Baker, Asst. General Manager, The Mexican Corporation, Edificio, La Mutua, Mexico City, Mexico.
Charles Officer, Sullivan Machinery Co., Chicago, Ill.
A. S. Uhler, Ingersoll-Rand Co., New York City.
George D. Shaw, Efficiency Engineer, Denver Rock Drill Manufacturing Co., Denver, Colo.
H. T. Walsh, V. P., Sullivan Machinery Co., Chicago, Ill.
R. A. Scott, S. M., Denver Rock Drill Mfg. Co., Denver, Colo.
Bruce Yates, Homestake Mining Co., Lead, S. D.

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H. T. Walsh, Vice-President Sullivan Machinery Co., Chicago, Ill.
George A. Shaw, Efficiency Engineer, Denver Rock Drill Manufacturing Co., Denver, Colo.
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Albin F. Victor, Manager of Sales, Lake Superior Loader Co., Duluth, Minn.
H. DeWitt Smith, Superintendent of Mines, United Verde Copper Co., Jerome, Ariz.
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John Kiddie, Division Superintendent, Arizona Copper Company, Morenci, Arizona.

W. S. Boyd, Manager Ray Cons. Copper Co., Ray, Ariz.
T. Evans, General Supt., Cananea Cons. Copper Co., Cananea, Sonora, Mexico.
G. W. Nicholson, General Supt., United Verde Exten. Mining Co., Jerome, Ariz.

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J. C. Dick, Salt Lake City, Utah.
H. H. Miller, General Auditor, Hercules Mining Co., Wallace, Idaho.
H. L. Norton. Phelps-Dodge Corporation. Douglas, Arizona.
Harry Vivian, Chief Engineer Calumet and Hecla Mining Co., Calumet, Michigan.

JOINT MEETING OF COAL AND METAL SECTIONS STANDARDIZATION COMMITTEE

The American Mining Congress

MONDAY, NOVEMBER 15, 1920, 11 A. M.

Carl Scholz, Acting Chairman of the Coal Section; Chas. A. Mitke, Chairman of the Metal Section, presided.

The following were in attendance, including those who registered after the session started:

Barnhardt, G. W., Marion Steam Shovel Mfg. Co., San Francisco, California.

Bayles, L. C., Ingersoll-Rand Co., Phillipsburg, N. J.

Boom, B. P., Westinghouse Electric Mfg. Co.

Brewster, T. T., vice-president Mt. Olive & Stanton Coal Company, St. Louis, Missouri.

Bright, G., Westinghouse Electric Mfg. Co., Denver, Colorado.

Broden, Charles E., Hazard Mfg. Co., Wilkes-Barre, Pa.

Burgess, George K., with U. S. Bureau of Standards and also American Engineering Standardization Committee.

Carroll, Frank, Ingersoll-Rand Co., Los Angeles, California.

Cottrell, J. G., Director U. S. Bureau of Mines, Washington, D. C.

Curry, J. E., Arizona Chapter of American Mining Congress.

Doubleday, F. E., Doubleday Coal Co., Fort Scott, Kansas.

Ebe, J. A., consulting mining engineer, LaSalle, Ill.; and manager of Mining Department of Illinois Zinc Co., Peru, Illinois.

Golden, James, Mining Inspector, Fourth District, W. Va.

Grensfelder, N. S., Hercules Powder Co., Wilmington, Del.

Hall, R. D., *Coal Age*, New York City.

Jowett, J. H., Ingersoll-Rand Company, New York.

Kasemen, G. A., president Albuquerque & Cerrillos Coal Co., Albuquerque, New Mexico.

Kiddie, John, superintendent Mining Department, Arizona Copper Co., Clifton, Arizona.

Kipp, Ernest B., local representative Hazard Mfg. Co., Wilkes-Barre, Pennsylvania.

Kiser, A. V., superintendent Electric Equipment Coal Co., Pittsburgh, Pennsylvania.

Lampinen, E. O., Kavehills Coal Co., South Dakota.

Larson, C. W., engineer Mining Dept., General Electric Co., Erie, Pa.

Longyear, Robert D., E. Y. Longyear Co., Minneapolis, Minn.

Lunt, H. F., State Commissioner of Mines, Denver, Colo.

Marks, J. B., Colorado Fuel & Iron Co., Denver, Colo.

Milliken, James, president Industrial Car Manufacturers Institute, Pittsburgh, Pa.

Mitke, Charles M., consulting engineer, Bisbee, Arizona.

Morrison, A. Cressy, National Acetylene Assn., New York City.

Mott, Chester, district manager, Sullivan Machinery Co., Denver, Colorado.

McKeehan, D. C., Union Pacific Coal Co., Rock Springs, Wyo.

McKinley, C. S., Denver, Colorado.

Needham, John, Mining Department of the Chicago, Milwaukee & St. Paul R. R., 63 E. Adams St., Chicago, Ill.

Norman, Fred., The Alleghany River Mining Co., Kittanning, Pa.

Notman, Arthur, superintendent, Mining Department, Phelps Dodge Corporation, Bisbee, Arizona.

Officer, C. H., Sullivan Machinery Co., Chicago, Illinois.

Parker, Richard A., representing the Mining and Metallurgical Society of America, Denver, Colorado.

Rait, E. M., Arizona Mining Co., Clifton, Arizona.

Richards, J. W., assessor, Denver, Colorado.

Richards, P. J., coal analyst, Denver, Colorado.

Risdon, W. W., State Mine Inspector, Gallup, New Mexico.

Robinson, Harry W., attorney-at-law, Denver, Colorado.

Robinson, —, General Electric Co., Denver, Colorado.

Rowe, W. A., American Blower Co., Detroit, Michigan.

Scholz, Carl, Jr., Raleigh-Wyoming Coal Company, Charleston, West Virginia.

Scott, R. A., Denver Rock Drill Mfg. Co., Denver, Colorado.

Smith, C. D., Goodman Mfg. Co., Chicago, Illinois.

Smith, Roy F., Empire Zinc Co., Denver, Colorado.

Thompson, G. S., Fuel Department, Colorado Fuel & Iron Co., Pueblo, Colorado.

Uhler, A. S., Ingersoll-Rand Co., New York.

Victor, A. F., Lake Superior Motor Co., Duluth, Minnesota.

Walsh, H. G., Sullivan Machinery Co., Chicago, Illinois.

Watts, C. E., Berwind Coal Co., Windber, Pennsylvania.

Wilson, H. M., general manager The Associated Companies, Hartford, Connecticut.

CHAIRMAN MITKE: Mr. Scholz and I have decided that instead of

taking up technical matters this morning, we will confine our discussion to subjects of general interest to the Coal and Metal Sections.

The method of procedure adopted by the Metal Section of the Standardization Committee, is as follows:

First, a general committee, consisting of a chairman and six members was appointed, each of the seven being in turn, chairmen of the Sub-Committees. Seven Sub-Committees, were then appointed, the personnel representing practically every mining State in the Union.

Meetings not Suitable; Work by Correspondence

Owing to the fact that our Committee members live so far apart, frequent meetings were out of the question, and all the work must therefore be carried on by correspondence. In order to provide a working base, questionnaires have been prepared by the various chairmen and sent not only to Committee members, but to operators in district not represented by them. Upon receipt of these questionnaires, properly filled out, the information thus obtained is tabulated and then sent out to the Committee members for their study, comments, and suggestions. By this means it is hoped that valuable deductions may finally be evolved, which will prove of material benéfit to the mining industry. This is the plan of the Metal Section. Mr. Scholz, who, in Colonel Roberts' absence in Illinois, is acting chairman of the Coal Section, will give us an outline of the manner in which that Section is functioning.

MR. SCHOLZ: Colonel Roberts has been in charge of this matter and will make a report later on, showing how effective his work has been. Unfortunately, I have not had time to give the subject the full consideration it deserves. I am sure, however, that the Committee is going to do a lot of good.

The Committee of which I am chairman—on Mining and Loading Machinery— is an important one. We feel that with the high cost of labor, mechanical mining and loading is more in demand than ever. Our idea has been to standardize certain general equipment on which we could agree. We found that there were more differences among the manufacturers than we felt should exist. Of course, we realized that every manufacturer has certain professional secrets which he keeps himself, which we should approach with more or less consideration and care; but I do feel that we ought to get closer together than we have, in order to simplify the question of repairs and maintenance and other matters, although equipment matters are such that we may not be able to do much with them at this time. Of course, we do not care to standardize such things as miners' houses, because it requires a diversity; but as far as equipment is concerned, when we sample the parts in the interest of the manufacturers, it will enable us to test machinery that otherwise would be barred, because every company operating far from a manufacturer knows what a tremendous amount of money it requires to secure a stock of repair parts. The detailed reports I understand will be read at some later meeting. The present object is to get acquainted and see what we could agree upon as to a plan of action.

MR. MITKE: Has anyone any suggestions about the general plan of investigation that we should adopt, or anything whatever to offer?

MR. G. BRIGHT: I should like to bring up something in connection with the Committees on Coal Mining and Metal Mining. In many instances the work is entirely different. Some of the Committees on the latter have subjects to consider which do not concern coal at all, and I

Merging of Committees on Parallel Subjects

understand there are other Committees that are almost parallel. I think that it would be somewhat advantageous for those Committees—for instance, Underground Transportation—to work together; otherwise, if they work entirely separate, it looks as if they may come in with recommendations that are rather far apart, and it would be rather difficult for the American Mining Congress to issue these recommendations to the public when they do not agree at all; while if these Committees worked together, they could no doubt come to some definite agreement on which the same standards could be reached. Conditions are different in coal and metal mining; on the other hand, there are some conditions on which the same standards could be reached.

MR. MITKE: Your idea is that transportation is transportation the world over?

MR. SCHOLZ: So is drainage.

MR. BRIGHT: Of course, ventilation and some problems like that are similar.

MR. A. V. KISER: Underground equipment and underground transmission are parallel, and we should not bring in a recommendation which we think is not concurred in by the Metal Mining Committee.

MR. MITKE: The Sub-Committee on Coal Transportation and the Sub-Committee on Metal Transportation might get together, and compare and correlate their reports.

MR. KISER: Yes, after their Committees agree on the reports.

MR. BRIGHT: When it comes to the final meeting, at the end of next year [1921], we are hoping that we will have something that is really worth-while, but in the meantime they can exchange their reports, long before that, and have them pretty well discussed.

MR. MITKE: That is a good suggestion. In fact, I understand some of the reports of the Committees of the Coal Mining division are ready for publication and distribution now.

MR. SCHOLZ: I wish to hand in the report of the Coal Mining branch of this Committee to be read, if the time affords.

MR. MITKE: I believe it wiuld be better to defer that until the meeting of the Coal Section tomorrow morning.

Mr. Notman has some suggestions about the progress in carrying out the investigation which might be helpful in facilitating matters more or less, especially in arranging details.

MR. ARTHUR NOTMAN: I have given the matter quite a little thought, but I do not know whether my ideas will agree with the other members of our Sub-Committee or not. I am on the Sub-Committee on drilling machines and steel, and I received with interest the questionnaire from our chairman, Mr. Braly, who, unfortunately is not here, but I was unable to complete it before leaving Bisbee. We have been engaged in an investigation on the subject during the past six months, and I have a report which I hope to be able to present to Mr. Braly in person, but with Mr. Mitke's permission I will present it at the meeting of the Metal Section tomorrow afternoon. It occurred to me, that in order to expedite matters, it might be advisable to have an inner circle, covering this Sub-Committee—which I understand has a membership of about forty—and discuss the question in detail, and have them, with Mr. Braly, go over the questionnaires, and any detailed reports that may be presented here, and summarize—as our Chairman has suggested—all that information.

Question of Procedure

Then there could be at least one meeting of that smaller group, prior to the next annual convention of the Mining Congress, early enough so that their resolution or report to their chairman could be referred back to all the members of the Sub-Committee on drilling machines and steel for their criticism and suggestions, in advance of the Mining Congress meeting. As Mr. Mitke has pointed out, it is extremely difficult for the mining industry, particularly because we are so scattered, to get any representative number together and discuss a question like standardization, which is almost entirely a matter of detail, and in order to accomplish something, we must have a few men who can get together.

I have three copies of my report which I would like to give to representatives of drill manufacturers in advance of the meeting tomorrow, so that they might have an opportunity to digest it and discuss it at that time.

MR. MITKE: I shall now read a report sent by Colonel Roberts, concerning the meeting of the General Correlating Committee of the American Engineering Standards Committee, held in New York recently:

The report states that, in accordance with a call sent out by Mr. P. G. Agnew, secretary, a conference was held in New York on November 11, 1920, with representatives present from each of the five national organizations and societies to whom the call was sent, namely, the (1) American Institute of Mining and Metallurgical Engineers; (2) American Mining Congress; (3) Mining and Metallurgical Society of America; (4) National Safety Council; and (5) U. S. Bureau of Mines.

These had previously named the following as their representatives on this general correlating committee:

(1) Howard N. Evanson and Graham Bright; (2) Charles A. Mitke and Col. Warren R. Roberts; (3) B. B. Gottsberger and E. S. Berry; (4) J. S. Williams and F. P. Sinn; and (5) O. P. Hood. The following were present in person or by alternatives: (1) P. E. Barbour; (2) Colonel Roberts; (3) B. B. Gottsberger; (4) F. B. Sinn; and (5) O. P. Hood.

The Minutes of the first conference of this general correlating committee, as hurriedly prepared by the secretary of the American Engineering Standards Committee, are hereto attached. These minutes represent substantially the work accomplished and the agreements reached at this first conference. They are signed by Colonel Roberts.

Report of Correlating Committee

"The minutes of this conference should state that Mr. A. A. Stevenson, chairman of the American Engineering Standards Committee, and Mr. P. G. Agnew, secretary of this Committee, were unanimously selected as temporary chairman and temporary secretary for this first conference of this General Correlating Committee, it being the sense of the representatives present that the permanent chairman and secretary should not be selected until the next conference of the committee, when it was hoped a fuller representation of the societies would be present.

It should be noted that the representatives present for some of the societies did not feel disposed at this first conference to bind their societies to any definite program, and wished to refer the matters back to their society for formal approval. However, it was their personal judgment that their program of correlation, as tentatively agreed upon at this conference, would be approved by their societies.

Colonel Roberts, representing the American Mining Congress, advised that it was very important that some such general program for correlating the standardization work, which was being carried on by the various organizations and societies named above, or which they might wish to enter upon, should be agreed to at this conference, for the reason that the American Mining Congress would expect its representative at this conference to report at the first National Standardization Conference, to be held in Denver, November 15 to 19, inclusive, whether any such program had been agreed upon, and if so, the substance of such program. It was for this reason that the temporary chairman of the meeting urged upon the representatives of the various societies that they reach, at least, some tentative agreement, which was done as outlined in the minutes of the meeting above referred to.

Your representative at this conference advised the representatives of th other societies present, that the general correlating program, as tentatively agreed upon, met with his personal approval, and that he would so report at the first National Standardization Conference of the American Mining Congress and recommend the acceptance of such program by our Congress.

All Organizations to Outline Their Activities

As indicated in the first paragraph on the last page of the minutes of this conference, the representative of each organization present agreed to prepare a brief outline of the activities of this organization on standard-

ization work as applied to the mining industry. Such presentation of the work of our Mining Congress on standardization can better be prepared at a date after our National Convention.

The conference adjourned subject to call of the chairman or secretary of the American Engineering Standard Committee. It was, however, tentatively agreed to by the representatives present that the next conference should be held in New York City about the middle of December (1920), at some date to be mutually agreed upon by the representatives of the various organizations. At this next conference it was expected to complete the organization of this general correlating committee by selecting a permanent chairman and secretary; and it is also hoped that at this next conference the representatives of the various organizations will have secured the approval of their respective societies to the tentative program as outlined above in this report, which will enable this committee then to prepare a definite program for correlating the standardization work of all these organizations and societies."

MR. GEORGE K. BURGESS: Speaking as a member of the American Engineering Standards Committee, I might say that I was sorry not to be able to be at that meeting of November 11, but in general I think that the long view ahead, as mentioned in Col. Roberts' report, was of great importance. The program as outlined by your chairman earlier in the meeting is all right—there is no question about standardization being good—but the function of the American Engineering Standards Committee is not to make standards; the function of that committee is to supervise the methods, the fundamental idea being that all interests concerned in any given standardization project or industry, will be representative.

Interlocking of Organizations

That, however, does not prevent—on the contrary it leads to the encouragement of active work on any particular unit representing either a large portion or any portion of the industry in question. In the mining industry there are several bodies interested directly—some of them indirectly,—in standardization methods. Therefore, before a standard is promulgated as an American standard,—that is, representing decisions which are subscribed to by the whole country—some process as indicated in Col. Roberts' report of the November 11 meeting, is inevitable, namely, that we must not only get together in this organization, but you are to join with other similar organizations working on the same problem. Therefore, the proper way to organize this standardization work is to go ahead with your own committees, at the same time tying up with other organizations. I think if that policy is adopted, it will lead to greater, more definite, and efficient progress than by any other procedure.

MR. N. S. GRENSFELDER: Has it been decided definitely about that meeting in New York mentioned in Col. Roberts' report?

MR. MITKE: It is to be some time in December, 1920.

MR. A. C. MORRISON: Is there any objection to reading the tentative agreement, or is that to be postponed until some other meeting? Mr. Roberts refers constantly to a tentative agreement which had been reached, and he recommends its adoption, but the agreement is not before the meeting.

MR. MITKE: I have not read it yet as it has just been received, but will now do so. It is signed by the secretary, P. G. Agnew.

"The meeting was called to order by Mr. A. A. Stevenson, Chairman of the American Engineering Standards Committee, at 2:30 p. m.

Those present were Percy E. Barbour, representing the American Institute of Mining and Metallurgical Engineers; Warren R. Roberts, the Mining and Metallurgical Society of America; F. P. Sinn, the National Safety Council; O. P. Hood, the U. S. Bureau of Mines; A. A. Stevenson, chairman, American Engineering Standards Committee, and P. G. Agnew, secretary, American Engineering Standards Committee.

It was announced that the following gentlemen who have been designated as members of the Committee, representing their respective organizations, were unable to meet with the conference. They included Messrs. Evanson, Bright, Mitke, Berry, and Holbrook, and others.

In view of the absence of several members of the Committee, it was decided not to proceed with the election of a permanent chairman, and upon motion by Col. Roberts it was voted that Mr. Stevenson be requested to act as temporary chairman. Mr. Stevenson consented to serve. The Secretary of the American Engineering Standards Committee was requested to serve as secretary of the meeting.

The Mining Congress and Standardization

Methods of co-operation. Col. Roberts briefly outlined the work of the American Mining Congress. The Congress was to hold its annual Convention in Denver the following week, and one of the principal features of the Convention would be a general conference on standardization in the mining industry. It was very desirable that some agreement be reached as to the general method of co-operation, and to be followed in correlating the standardization work of the various organizations, in order that the work might be finally approved by the American Engineering Standards Committee. The Standardization Conference in Denver should be apprised of the methods to be followed.

Mr. Hood briefly outlined some of the standardization activities of the Bureau of Mines, and pointed out, by use of illustrations, the importance of clearly defining the relation of each of the co-operating organizations to the American Engineering Standards Committee.

In the frank and rather full discussion which followed, it was recognized that the main function of the present Committee would be to work out the methods of correlating the standardization activities of the various organizations concerned, in order that specific parts of the work should receive final approval of the American Engineering Standards Committee after clearing through the mechanism of co-operation to be agreed upon.

It would be first of all necessary to work out a general policy and plan to be followed in the work. The Committee would then have to apply this plan to specific projects, acting as technical advisor to the American

General Plan

Engineering Standards Committee in the mining field. It was recognized that in the application of the general plan there would be involved such work as:

(1) Delimiting specific projects which might be most advantageously handled as units.

(2) Recommending the order in which the various projects should be taken up in view of the needs of the industry.

(3) Make recommendations as to what bodies should act as sponsors for specific projects, and as to what bodies should be represented upon sectional committees.

It was agreed that the members should recommend to their respective organizations the following as a general plan for co-ordinating the present standardization activities of the different bodies and placing the work under the rules of procedure of the American Engineering Standards Committee.

(a) If an organization has a standardization project practically completed or well under way, the organization should be recommended as sponsor (either as sole sponsor or as joint sponsor, with another organization, according to circumstances).

(b) If the organization has a committee organized and working on the subject, the make-up and representative character of the committee in sponsor (either as sole sponsor or as joint sponsor, with another organadequately representative, it could become the sectional committee.

If found not to be completely representative, the committee in question, or a portion of it, could serve as the nucleus of a more broadly representative sectional committee.

It was felt that this sectional plan would fit in with the procedure established by the American Engineering Standards Committee, and would not interfere with the progress of the work now in hand.

Relation to Safety Code Program: The relation of the work to that of the National Safety Code Committee was briefly discussed. It was voted that the Secretary be instructed to write to the National Safety Code Committee, informing them of the organization of the General Correlating Committee, and apprising them of the desire of the General Committee to co-operate with the National Safety Code Committee.

The Safety Code Program

It was further voted that the Secretary be instructed to prepare a brief outline of the history of the Safety Code Program, and of the work of the National Safety Code Committee, and circulate it to the members of the General Committee.

information on standardization activities of the organizations. It was agreed that each member present should prepare a brief outline of the activities of the Organization which he represents, which bears on mining standardization, and forward it to the Secretary who would circulate the information to the members.

Circulation of minutes. It was voted that copies of the minutes should be sent to the Secretaries of the five organizations, in order that each organization might have in its central office a file for the information of its members.

The meeting adjourned at five o'clock p. m., subject to the call of the chair.

Mr. Mitke: In this connection I would like to say that in arranging the general program of the Metal Section, we have endeavored to make the adoption of standards just as difficult as possible, in order to prevent any one man's ideas being forced upon the mining industry, unless it has first withstood the criticism of the majority. This measure has been adopted as a safeguard, and for the protection of both the manufacturers and the mining industry at large.

The meeting then adjourned until the following day.

NATIONAL STANDARDIZATION CONFERENCE

The American Mining Congress

WEDNESDAY MORNING, NOVEMBER 17, 1920

Chas. A. Mitke, chairman of the Metal Section of the Standardization Committee, presided.

CHAIRMAN MITKE: The First National Standardization Conference will please come to order.

In the absence of Mr. Scholz, who is unfortunately unable to attend, I will open the meeting by reading a paper on 'The Relation of Standardization to Mine Management.'

[Mr. Mitke's paper appears on page 772 of the Proceedings.]

MR. MITKE: We are very fortunate in having with us Mr. P. G. Agnew, a man who is interested in the working out of national standards.

[Mr. Agnew's paper appears on page 211 of the Proceedings.]

Address by Colonel Roberts

Next follows the address 'Standardization and Efficiency' prepared by Col. Warren R. Roberts:

When the founders of the American Mining Congress, in keeping with custom, selected a motto, they chose one that would indicate to the public the purpose for which this Congress was organized, and also the ideals toward which it would strive. No other words could better have expressed these objects than "Safety, Efficiency, and Conservation."

SAFETY has been one of the watchwords of our Congress from the beginning. Not only have the officials of our Congress improved every opportunity to promote safety as applied to the mining industry, but they have been among the first to conceive ways in which improved and safer methods and practices could be brought before the mining industry.

In confirmation of the above statement, we remember that when the U. S. Bureau of Mines was in process of formation by its Director, he had no more ardent supporter and efficient adviser than our honored secretary, Mr. James F. Callbreath, who has since, together with his other officials, always extended a helping hand to the Bureau. Those of us who are familiar with the work of this Bureau, know that it has been the greatest agency in the land for the promotion of safety in the mining industry.

Our Congress has also co-operated at all times with all other agencies promoting safety as applied to mining, and at the present time working

together with the National Safety Council and similar organizations so far as their efforts are directed toward the mining industry.

EFFICIENCY, the much abused and often misapplied expression, has never been misunderstood by the officials of our Congress. If we would gain the confidence of others, and thereby secure influence with them, we must first be able to show that we have applied intelligently to our own affairs the advice we offer them. The conduct of our work through our own efficient organization has always been an example of efficiency to the mining industry. In the years that I have been connected with this organization, many times I have heard prominent men in the mining industry make the above statement. Due to this fact our Congress has had much influence with the mining industry in promoting efficiency added to safety.

CONSERVATION is a most popular expression with those who seek to gain public influence. We talk flippantly of the conservation of our national resources, while we continue to waste them. It is an acknowledged fact that the American people is the most extravagant and wasteful nation on earth. Such extravagance is not applied only to their personal resources, but to those of their cities, their states, and their nation. We were so greatly blessed with the great natural resources of our broad acres of fertile land, with our limitless forests and our unbounded mineral possessions, that we have for generations gone on exploiting these resources in the way that were bringing us the most immediate results with very little thought of conserving those wonderful possessions.

But as our lands were gradually occupied, and as our forests disappeared, and the richer of our mineral resources were exhausted, we began to take account of our wastefulness. The wiser and more patriotic of our citizens began to plead for conservation of these great resources and then I say, this word became very popular with many persons who are always ready and waiting to ride into public favor on the crest of some friendly wave. Such use of any national movement like conservation naturally creates much prejudice with our people, and this must be overcome by the industrious and wise efforts of those who are seeking to promote real conservation. Our Mining Congress has been diligent in its efforts to conserve the energies, the capital and the resources of the mining industry, thereby living up to its motto of "Safety, Efficiency, and Conservation."

Standardization an Economy

When this excellent motto was adopted by the founders of our Congress, they were not familiar with another great force in national economy. This other important factor was not then generally recognized, even by the engineering profession, which is always among the first to point the way in all matters pertaining to safety, efficiency, and conservation. There were those, however, in this profession who did have the vision to recognize that standardization of methods as applied to production, whether it be applied to mining, manufacturing, or otherwise, was

the real basis upon which should be built up the three structures of safety, efficiency, and conservation. Those of us who are familiar with this movement, which has now reached national proportions, even international scope, can verify the above statements. However, while the foundations for this new movement have been intelligently laid, no material progress had been made up to the time when our Nation was rudely awakened from the complaisant tenor of its ways of peace, and found it necessary immediately to reorganize our entire national life to enable us to meet this great crisis which was endangering our very existence. It took even such a crisis as this to awaken the American people to a realization of our resources and of our capacity as a Nation, but we did find ourselves, so to speak, and we were a surprise to all the nations of the earth as well as to ourselves.

We were proud then, and we are now, to recount the inventions, the creations, and the accomplishments of our people when as a united force they went about this great task.

But the bulwark of our strength at that time was the almost unlimited capacity of our engineers, scientists, and professional men generally, to meet this great emergency by inventing new things and new methods, and applying other things in more scientific and practical ways and otherwise helping them to organize our resources on the most productive and economical basis.

Concentration During War Years

When the call came for more ships, and when these could not be built fast enough to meet the ever-increasing demand for our shipments to Europe, a way must be found to make the vessels we had carry greater cargoes. Then again, our scientists and engineers were called upon to meet this new demand. We must find a way they told us, to concentrate and condense our cargoes. This demand was met by putting into practice the theories of those who had advocated standardization of packing, boxing and baling of all products for transportation, either by land or sea. We cannot go into detail at this time as to how this was accomplished, but can only state that a surprising increase in shipments was readily made by applying methods of standardization as above outlined.

Another call was for increased production from our factories for every article needed to carry on the war. Again, standardization of methods and of equipment very greatly facilitated, not only production but again transportation of the articles thus produced. We could go on multiplying examples to illustrate how standardization made for efficiency in every department of production and transportation during the period of the war, but this brief statement will suffice to indicate to you that any agency which was the basis of the greatest economics that we wrought during this period, must have value which should be applied to the same industries and to others in times of peace.

We have not forgotten the lessons we learned during the strenuous time of the war when necessity drove us to acomplishment. We have, therefore, been diligent in trying to apply to our industries as now re-

organized, the benefits to be derived from standardization in methods of production and of manufacture.

The American Mining Congress immediately after the war undertook to organize a division to promote standardization of mining methods, mining equipment, etc., for this industry.

Result of Conferences on Standardization

This work soon gained such prominence that other national organizations interested in the mining industry, and more particularly in this movement of standardization, suggested that a conference be held with the object of co-ordinating the work of these various national societies and organizations. These conferences have all borne fruit, and this work of co-ordination has already been accomplished through an organization set up especially for this purpose, namely, the American Engineering Standards Committee.

The way has, therefore, been opened, the trails blazed and it only remains for those who are promoting this important work to carry it forward to consummation, thereby bringing to the mining industry through standardization, Safety, Efficiency, and Conservation.

May we not hope also, that progressive men in other industries, seeing the economies we shall work through standardization, for the mining industry. will be encouraged to 'Go thou and do likewise.' "

MR. MITKE: Mr. T. T. Brewster will speak to us on 'Standard Mine Accounting.'

[Mr. Brewster's paper will be found on page 818 of the Proceedings.]

MR. MITKE: Mr. Brewster has given us an interesting talk, and those of you who are interested in this subject can obtain copies of the report; also copies of the paper Mr. Agnew brought for distribution.

We have with us Mr. James Milliken, president of the Industrial Car Manufacturing Institute of Pittsburgh.

In presenting the attached report Mr. Milliken made the following explanatory remarks:

Gentlemen, this report is not nearly as formidable as it looks. The time for adjournment is about here, and I am not going to detain you very long. I did write a short address and I will turn it over to the Secretary and you can read it in the Proceedings.

I want to compliment you on what has been done this year in the matter of standards. It represents a good piece of work, and I would like to emphasize first a few remarks that I made yesterday to the Coal Mining Section, because I think it applies to all standardization work.

Standards in Railroads

First is your method of procedure—the correlation of your committees. It is one thing to prepare standards, and another to get your members to adopt them entirely. You can make all the standards you want, and unless your members will actually agree to use them, you might as well

not have any standards. My experience has covered a good many years in railroad service, and you probably all know that the railroads, in their car construction, have done a great deal in the way of making standards. Although they started in 1872, the full standard car is not yet being built. However, the parts of cars that wear out are standardized and are interchangeable, so that if a Pennsylvania car in the East wears out a wheel, or something of that kind, either here or in San Francisco, the repair man there puts on a piece from his own stock. In that way, the cost of repairs has been materially reduced.

I would like to suggest that instead of making standards as you start out, you make recommended practice. I think you will find it will be accepted by your members much more readily than if you tried to force a standard onto them. I think the best way to accomplish that is to submit all suggestions to members individually in the way of a recommendation; then you will ascertain completely whether your recommended practices will be suitable, and after such practices have been in use for a few months, or a year or two, they can readily be advanced to standards.

The Committee that I am connected with, known as the Industrial Manufacturers Institute, is trying to standardize industrial equipment. Outside of a standard coach for railroads, there are really no standards. We have been in operation about 1½ years, and have adopted a large number of recommended practices, the items that you are particularly interested in being mine-cars. We have adopted recommended practices, covering all kinds of materials used, such as bolts and nuts, castings for malleable iron, gray iron and steel, general pipe-unions, welded pipe, rivets, screw-threads, structural steel, and so forth.

Variety in Mine-Cars

It is really remarkable how few standards there are in the building of mine-cars. This Commission that I am connected with can do a good many things, but we canont do it all. It is up to you gentlemen to establish standards, and then the car manufacturers will be only too glad to build what you want. But they do not want to have to build a different type of car for every mine, and there certainly is not any occasion for that.

At the present time we are trying to standardize treads and flanges of wheels. Your present flanges and treads of wheels shows a wide range, resulting in a tremendous amount of waste material. There is certainly one correct tread and flange for an 18-in. wheel, and there is one correct weight for your different capacity cars. If you adopt one standard flange and one weight for capacity, if you will get the best engineering talent, if you will get the best designed wheel, you will not be carrying around excess weight, neither will you have a wheel that is too light for the service.

The same thing applies to practically all the details of cars. I am not going to mention them all, but I would like to mention Turner bearings. You have five or six different capacities, from one to five tons—a few half

tons. The majority of them have roller bearings that are rather expensive to make. There are some 18 or 20 different sized Turners for those four or five capacity cars. Some of them are 1$\frac{15}{16}$ in., and another is 2 in., and another is 2$\frac{1}{16}$ in.

It costs money to have three size of roller bearings made, where one size can be made in three times the quantity, and for that reason you will get them for considerably less price. There are really many advantages in standardization, and I want to assure you that the Industrial Car Manufacturers Institute is only too willing to co-operate with you, with your operators, mine superintendents, and with your engineers, and wherever we can be of service, we will only be too glad to do it.

The meeting then adjourned until the following morning.

THURSDAY MORNING, NOVEMBER 18, 1920

Carl Scholz, Acting-Chairman of the Coal Section, and Chas. A. Mitke, Chairman of the Metal Section, presided.

CHAIRMAN MITKE: This is a continuation of yesterday's meeting, and is the final meeting of the Standardization Conference. The first speaker is Mr. G. K. Burgess, a representative of the U. S. Bureau of Standards, a man whom you have heard before, and who will give us an intelligent view of the work of the Bureau.

[Mr. Burgess' paper appears on page 794 of the Proceedings.]

MR. SCHOLZ: I have been requested by Mr. Mitke to read the following resolution, which will be passed without discussion to the Resolutions Committee:

> "WHEREAS, it is desirable that standardization in the mining industry be carried out on a national scale, in so far as it is possible to do so; and
>
> "WHEREAS, it is the desire of the American Mining Congress to co-operate in the fullest measure with other bodies working to the same end; be it
>
> "*Resolved*, That steps be taken, under such arrangements as may be mutually agreed upon by the bodies interested, through the General Correlating Committee for Mining Standardization, upon which the Congress is represented, to assure that the working standardization committees may be recognized as sectional committees of the American Engineering Standards Committee, in order that the standards prepared may receive final approval as American Engineering Standards."

Reports of All Committees to be Correlated

I might add that arrangements have already been made by the American Mining Congress to have a permanent secretary stationed at Wash-

ington, who will correlate the reports of the various committees. As acting-chairman of the Coal Section, I would like to say, for the benefit of the Metal Section, that the Coal Section meetings created a great deal of outside interest, so much so that one meeting extended over 3½ hours, and it was hardly completed then. A number of the Committees that had submitted reports were so impressed with the work which had been done, and with the work to be done, that they asked that their reports be returned so as to be revised and put into new form. Perhaps a number of our Committees were not quite aware of the final matters to be accomplished and we discovered that in many cases practices were referred to rather than equipment; and it may be necessary to augment that Committee by a committee on practices, rather than on equipment as we now have. We are much gratified with the interest that has been developed, and we hope that we will be able to do a great deal of good for the profession as well as for the manufacturers interested.

MR. MITKE: Right in line with what Mr. Scholz has said, I have an announcement to make:

As you are aware, the standardization of mining equipment is closely allied with the standardization of operations, and it is most difficult to standardize on one branch without standardizing the other. It has, therefore, been decided by the American Mining Congress, to enlarge the scope of all the working committees of both the Coal and Metal Sections to cover operations as well as equipment.

Mr. T. O. McGrath, auditor for the Shattuck-Arizona Copper Co. of Bisbee, will now address us on the subject of 'Standardization of Metal Mining Accounting.'

MR. McGRATH: I would like to say that this is nothing more than a preliminary presentation; it is not a detailed application to any one particular instance, it is a general discussion preparatory to taking up the matter in detail.

A Regulation Favorable to Mines Not Taken Advantage of

When I was at the Tax Conference here the other day, I talked to one of the men connected with the Tax Department, and I was much surprised to learn that one of the most important provisions in the last regulations had not been complied with or had not been taken advantage of, except by only one or two mining companies in the United States, so I thought I would mention this to you, because the last regulations make provision whereby these companies which had a large value as of March, 1912, saved themselves thousands of dollars, and in the case of larger companies, hundreds of thousands of dollars. The article is 844 of the Internal Revenue Department. I was told that there were only two or three companies that had taken advantage of it. That is not only interesting of this year, but it is particularly so in the fact that the Department has not finally settled any of the tax returns since 1917; in other words, your tax reports for 1917, 1918, and 1919 are still in abeyance. As I say, for some of the larger companies it amounts to hundreds of

thousands of dollars. If you wish later on to have me explain this article, I will be glad to do it.

[Mr. McGrath's paper will be found on page 806 of the Proceedings.]

MR. HANSON SMITH: In relation to Article 844—

MR. McGRATH: It would only take a minute to explain it: Article 844 allows you to depreciate and deplete the amount of your capital charges, not only in the amount of your investment in capital assets, but up to the amount of your value as of March 1, 1913; they allow your asset charges or capital charges, right up to the value of that date, which is appreciation. You take that up on your records. Then when you deplete those asset charges, you not only deplete the investment charge, but you deplete the appreciation value that they allowed to you, and set it up here as depreciation and depletion. Now, when you do that, Article 844 tells you that if you will divide your depletion charge—if your value was greater than the investment, and also your depreciation charge, if you wrote it up—if you divide it into depletion of investment and depletion of appreciation, you can use the amount of realized appreciation, for invested capital in making your return. And you can do that since March 1, 1913, or practically seven years. And in the case of some mines where they had a very large appreciation as of that date, that additional invested capital will amount to millions of dollars, which you will be allowed to use in figuring up your excess profits tax, and in some cases that will amount to hundreds of thousands of dollars.

MR. MITKE: Mr. Lawrence K. Diffenderfer, treasurer of the Vanadium Corporation of America, has sent an interesting paper on general methods of mine accounting, which I will ask Mr. McGrath to present in Mr. Diffenderfer's absence.

MR. McGRATH: This is an individual presentation of the application of mining principles to a mine, and probably will be very interesting to anyone who would like to see the system applied in an individual case. It brings up two good points: one is being very well versed in the operations; another, equipment records.

Two Papers Presented

[An abstract of Mr. Diffenderfer's paper appears on page 803 of the Proceedings. There were 13 typical forms of reports (including cash, timekeeper, payroll, storekeeper, supplies, purchasing, depreciation, and costs), but it was found impracticable to reproduce them.]

[Mr. Joseph F. Merrill, Director of the School of Mines and Engineering, University of Utah, representing the World Metric Standardization Council, presented a paper on the use of the metric system in place of the present method of weights and measures. The organizing members of this Council are the Foreign Trade Club of San Francisco, American Metric Association, London and Manchester Decimal Association, American Chemical Society, and American Wholesale Grocers' Association.

There are on file in Washington 100,000 petitions, urging gradual adoption of the metric system in America. Of 58,226 petitions received under one questionnaire, there were only 426 opponents to the suggestion. The advocates included many prominent men, in science, education, and commerce. Mr. Merrill stated that its advantages were simplicity, economy, and universality. The remainder of the paper consisted of quotations from public men who were in sympathy with the movement.]

COAL MINING SECTION, STANDARDIZATION COMMITTEE

American Mining Congress

NOVEMBER 16, 1920

Mr. Carl Scholz, Jr., presided.

CHAIRMAN SCHOLZ: Gentlemen: According to the program, Colonel Warren R. Roberts, who is chairman of the Coal Section, was to preside and present his report, but unfortunately he could not attend, so has asked me to present his report and act in his stead. The report is as follows:

Report of Colonel Roberts

The Coal Mining Branch of your Standardization Division of the American Mining Congress presents the following report as representing the progress made during the year since our last annual Convention.

This report is rendered by the General Committee directing Standardization for the Coal Mining Branch, and on behalf of the seven Sub-Committees having in hand the work of improving the practice and standardizing the methods and equipment for the coal-mining industry.

The first report of this General Committee presented at our last annual Convention indicates that this work was, at that time, only fairly begun; that is to say, the General Committee and the various Sub-Committees had been organized and had held a series of conferences just prior to the annual Convention, at which time they had developed and agreed upon a general program of standardization to be applied to coal-mining practice, equipment, etc. The Conference also developed arrangements whereby the work to be performed by the several Sub-Committees would be co-ordinated through the General Committee.

A comparison of the report rendered by your General Committee a year ago, and one herewith presented, suggests to your Chairman impressive facts, which he should call to your attention before entering into the more detailed subjects contained in our report.

We are impressed first, with the wisdom shown by your Committee in those first conferences, when the whole broad subject of standardization was discussed and conclusions reached covering the general scope which this work should assume, as well as the limitations that should best be applied to give the final results which would commend them to the industry, and thereby secure their adoption in general practice.

Good Work Accomplished

The several reports presented by the Sub-Committees which are attached to and form a part of this brief report of your General Committee, deserve special mention. Even a careful study of the reports of

these Sub-Committees would not indicate to you the vast amount of earnest discussion and careful consideration which has been required of the members of the Sub-Committees to reach the conclusions contained in their condensed reports. Your General Committee, therefore, wishes to commend to you the excellent work that has been done by all of these Committees with the exception of two, and for whom extenuating circumstances seem to offer ample excuse.

Our members generally, not being familiar with the work of our Standardization Division, it may be well to outline briefly the organization which is carrying on this important work on behalf of the mining industry. This Division is composed of two branches representing Metal Mining, and Coal Mining. The work of each of these branches is directed by a General Committee, composed of the Chairman of each of the Sub-Committees having direct charge of the Standardization of practice and equipment in their respective classifications of the work. The purpose of the General Committees is to review and co-ordinate the work of the several sub-committees.

The Chairmen of the two General Committees assist in organizing and directing the work for their respective branches and finally co-ordinate the work of the two Branches.

Standardization Attracts Attention

This work of Standardization, as carried on by the Mining Congress during the past two years, has attracted much attention from other national organizations and societies interested in the mining industry. Certain of these national organizations are interested in this work of Standardization, and in the campaign of safety as applied to the industry. This community of interest resulted in the calling of a conference of representatives of these various national organizations and societies, which formulated a program for co-ordinating the work in which they were mutually interested. After a thorough discussion of the subject by representatives in conference from all of these organizations, it was decided that the co-ordination of this work of Standardization could best be carried on through another national organization set up especially for this purpose, namely, the American Engineering Standards Committee.

A separate report will be presented to the Standardization Conference on this subject, and we will therefore only state that your Standardization Division is in hearty sympathy with this movement for co-ordinating and giving a national character to this work of Standardization for the mining industry.

Invitation has been extended by the Chairmen of your two General Committees to all the national organizations and societies interested in Standardization of mining methods and equipment, to attend the first National Standardization Conference, and to participate in the discussion and work generally of the conference. We are pleased to advise that representatives have been sent to our conference by all of these organizations and societies.

This work of Standardization has now been put on a truly national

basis, and the American Mining Congress may have a just pride in the part it has had in helping accomplish these results, which indicate a final consummation of this important constructive work for the mining industry.

A Comprehensive Program

We must bear in mind that while a great deal has been accomplished as set forth above, that we must not slacken our efforts, in fact our energies must be multiplied to meet the growing requirements of the comprehensive program we have undertaken. We believe that the final benefits will fully justify all the labor and patience required by those having the vision to see the final results to be accomplished. In presenting the reports of our Sub-Committees—all of which are attached hereto—we recommend a careful review of these reports by our General Committee at its first session of the Standardization Conference. Such review of these reports will indicate the necessity for the co-ordination of their recommendations. To illustrate: referring to the reports of the Sub-Committees on Mining and Loading Equipment, and the Committee on Underground Transportation, we note that the track gages adopted by these two Sub-Committees do not agree. The General Committee, therefore, in conference with the representatives of the Sub-Committees should harmonize such features of their reports. This is only one illustration of several that could be mentioned indicating the necessity for the very careful review of these reports by the General Committee.

The General Committee should also, in reviewing these reports, consider carefully each and every one of their recommendations to the end, that we should not suggest standards for adoption by the industry which shall meet with general opposition. We must always bear in mind that standards require general adoption by the industry to make them of value.

We recommend further that the General Committee refer to the General Conference on Standardization all subjects on which they believe that a general discussion by the conference would be beneficial.

It will be found on reviewing these reports, that many important questions justify a very broad and full discussion before final recommendations should be made by our General Committee to the Conference for adoption.

Procedure

After the adoption of these reports as revised by the General Committee, or by the General Committee in conjunction with the Standardization Conference as suggested just above, we then recommend that these final, approved reports be submitted to the Standardization Conference for approval and adoption.

MR. SCHOLZ: I will call on Mr. Thomas T. Brewster, chairman of the Committee on Cost Accounting, National Coal Association.

MR. BREWSTER: I have not prepared a set address, but have brought

with me 150 copies of the report of the National Coal Association, which was presented to that body at its annual meeting a year ago. That report has found favor with the Treasury Department, also with public accountants; and a number of the coal operators throughout the country have adopted this form of accounting. What I propose doing later is to make some remarks introducing that report, referring to its salient features, and then distribute the copies mentioned.

[An abstract of Mr. Brewster's paper appears on page 818 of the Proceedings.]

MR. SCHOLZ: The Committee would like to have a written report from all the Chairmen. It need not necessarily be long, but they should give some of their thoughts for discussion. Standardization work is not simple; in fact, it is a difficult problem, because we meet opposition from

Committees Include all Technical Men

the most unexpected quarters. In selecting my committee I included three coal operators, three mining engineers, and the remainder is made up of representatives of the manufacturers. For instance: Mr. A. V. Kiser is chairman of the Committee of Underground Power and Transmission, and that Committee has made a voluminous report, perhaps the best report of any of them. They are evidently composed of workers and men who know things, because they have surprised me with a number of facts which I did not know existed. I will be glad to have Mr. Kiser give us a resumé of the salient points of his report.

MR. KISER: I might say that we experienced serious difficulty in getting men to work on these Committees. We found that many of them whom we wanted gave as an excuse that they were too busy, and we concluded in the event that we required assistance in the future, that we would get someone who was in an official position with the American Mining Congress, to write the president or vice-president of these companies, and put the case before them, and tell how urgent it was that their engineers get in on this work.

[The joint report of the Sub-Committees on Standardization of Underground Power Transmission and of Power Equipment appears on page 688 of the Proceedings.]

MR. SCHOLZ: Are there any other remarks in connection with the report of the Committee on Underground Power and Transmission? If so, now is the time to present them.

Report By Mr. Scholz

The report of the Committee on Mining and Loading is short, and was written by myself. It is as follows:

The Sub-Committee on Mining and Loading Equipment submits the following report on its activity during the past year:

1. The increasing cost of coal production, coupled with the difficulties in obtaining efficient and sufficient labor for hand mining, makes the

adoption of mechanical means for mining and loading coal more important than heretofore, and it is recommended that manufacturers and mine operators, with their engineers, co-operate more freely in the use of equipment now available, with the view of developing methods by the use of which better returns be obtained from such machinery as it now on the market.

2. We recommend that in the construction of machines, the size and speed of motors, gears, drive-chains, and other parts be standardized as far as possible, so as to simplify the repairs and renewals of machines.

3. We recommend that the award of the Bituminous Coal Commission, with reference to the use of labor-saving devices, be given the widest possible publicity, thereby encouraging the installation and use of labor-saving devices, particularly in those districts where such machinery has heretofore been opposed by the United Mine Workers organization.

4. We recommend that the Standardization Committee of the American Mining Congress request mining schools and similar institutions to co-operate with this Committee, and through them, with the manufacturers of mining equipment, and coal operators in the development of mining methods to enable the greatest possible extraction of coal.

Following is a brief of the discussion on the Report of the Sub-Committee on Standardization of Mining and Loading Equipment by the Chairman of the General Committee:

Machines for Rapid Development

Mr. James Needham, general superintendent for the St. Paul Coal Co. and Republic Coal Co., said that the entry driving and loading machine is perhaps the only solution for the rapid development of a coal mine, but he believes that these machines require perfecting before they can be con-ered entirely satisfactory. He stated that the long-wall mines in northern Illinois are perhaps in as great need of mechanical loading appliances as any other mining field, but it has been found difficult to develop a satisfactory machine for long-wall mining, especially with the present excessive cost of operation. He hopes that a satisfactory machine for these mines may be developed, as present conditions are very discouraging.

Mr. W. D. Brennan, who was connected with the Hannah property of the Union Pacific Railway, explained to the Conference how loading machines were used in a coal seam 35 ft. in thickness and on a 17° pitch, where the rooms were driven along the strike. He stated that they had many difficulties in adopting these machines to this service, but stated that after a number of years of experimenting they now had machines in continuous operation which were giving them a production of from 800 to 1000 tons a day, with only 12 men actually used in the operation of these shovels. Additional men, of course, were required for handling of cars to and from the shovel, etc.

Mr. Scholz urged that for loading machines we should adhere to 220 volts for alternating and 250 volts for direct current. Experience had taught him that these voltages were preferable and most economical.

Mr. Kiser stated that the large operators of western Pennsylvania took exception to this recommendation by Mr. Scholz and considerable discussion on the matter followed. One of the recommendations of this Committee being that the size of motors, gears, drive-chains, and other parts be standardized so as to simplify the repairs and renewals of different makes of machines, a considerable discussion followed as to the possibility or desirability of carrying out this recommendation.

Mr. Ebe added that if it had not been for mechanical appliances it would have been impossible for his company to mine 400 or 500 tons of coal daily.

In reply to a query by Mr. Kaseman of New Mexico, whether it was the tendency of inventors to devote their attention to such devices as the steam-shovel for large veins, or for low veins, Mr. Scholz said that he believed most of the machines were for relatively thick seams—from 4 to 8 ft. Some shoveling or conveying machines will operate in coal as low as 5½ ft.

It seemed to be the consensus of opinion, however, that progress could be made along these lines and that small differences between the manufacturers on certain details could be avoided and in time that with the co-operation of the manufacturers very considerable improvement would be made which would work for economy in the maintenance of such machines.

With intelligent and conservative requests by the operators through their Standardization Committees, it is fully believed that the manufacturers will end such co-operation and that we shall finally progress much further along these lines than at present would seem possible, especially to those who have not given a great deal of thought to the matter.

CHAIRMAN SCHOLZ: The next matter on the program is the report of the Commitee on Standardization of Outside Coal-Handling Equipment, of which Col. Roberts is chairman, and will be presented by Mr. Needham:

Report on Outside Coal-Handling Equipment

The Chairman of this Sub-Committee has had such time as he could spare from his regular duties almost entirely occupied with the work required as Chairman of the General Committee of the Coal Mining Branch, consequently the work of this Sub-Committee has not received proper attention. We therefore suggest that the General Committee select a new Chairman for this Sub-Committee. The present Chairman will very gladly serve as a member of this Sub-Committee, but hopes that the General Committee will select from this Sub-Committee, as at present constituted, someone else to act as Chairman.

It was the sense of this Sub-Committee, as indicated in its report to the General Committee at our last annual Convention, that each Sub-Committee should first concern itself with the more general and important matters relating to the designing and installation of equipment included under their sub-division of Standardization and Mining Equipment. To this end it was recommended that each Sub-Committee should make a careful study of present practice, as related to the work of their Sub-Committee, and include in their first work the improvement and standardization of the general practice and methods relating to their sub-division work, and that this work should then be followed by a study of equipment included in their sub division of work, and endeavor to improve and standardize such equipment.

Following this general and comprehensive program, this Sub-Committee has taken under consideration, and begs to report suggestions and recommendations for the consideration of the General Committee as follows:

The study of present practice as related to the designing and building of coal tipples, head-frames, etc., indicates that one of the first and most important duties of this Sub-Committee is to try and improve and standardize the present practice which relates to the safety and economy in the operation of this unit of a mining plant.

Railroad Clearances

A study of present practice indicates that there is no uniformity in the clearance either horizontally or vertically for railroad tracks passing beneath tipples. This lack of uniformity and good practice in the various coalfields, has compelled certain railroads to promulgate regulations governing such clearances. In some instances, these regulations seem to be adequate and reasonable, and in other instances, they seem to be unduly conservative and impose on coal companies providing new facilities, expense that even good practice and safety would not require. Your Committee, therefore, after careful consideration of this matter makes the following recommendations regarding clearances for railroad cars:

A standard practice should be adopted, which would provide for a lateral clearance between the widest cars passing under such tipple, and the nearest tipple support, or any support built in connection with the tipple structure, of at least 18 inches.

That no support should be placed between railroad tracks passing under a tipple structure except between the two outside tracks, namely, the usual dump track and the one adjacent, except where the requirements make it absolutely necessary to insert supports between other tracks.

That the clearance between cars on tracks where no supports are inserted should not be less than 2 ft.

Referring to the vertical clearance above railroad cars passing under tipple structure, it has been difficult for your Committee to reach a satisfactory conclusion on account of the varying heights of railroad equip-

ment, and especially due to the fact that certain railroads have regulations regarding the passing of engines under tipple structures. However, your Committee recommends that this matter be taken up for discussion at our coming Standardization Conference, with the object of trying to secure suggestions from our members which your Committee will then take under further consideration.

We believe that this question of railroad clearances under tipple structures is of sufficient importance to warrant its most careful consideration with the ultimate object of trying to secure more uniform and safer practice.

To secure these results it may be necessary, after definite conclusions have been reached—which are satisfactory to the more progressive element in the industry—to enforce safe requirements regarding clearances by State legislation in respective districts where this may be required.

Clearances for Over-Wind

A study of present practice indicates that there is not sufficient importance given to providing adequate distance between the point of dump in tipples, and the first obstruction in the tipple above the point of dump.

When slow-speed hoists were in general use, so much importance did not attach to the question of proper clearance for over-wind. However, even in the past, properly designed tipples always provided a few feet of clearance above the highest point reached by the cage when dumping, and the nearest obstruction in the tipple or head-frame above.

With the present extensive use of high-speed electric hoists, this matter of clearance for over-wind becomes an important one, and a safe clearance should always be provided, taking into account the speed of the cage when entering the dumping horns, and also considering all devices to be installed both in the tipple or on the hoist to prevent overwinding.

Your Committee has not reached definite conclusions in this matter, and therefore wishes to refer it to the Conference for further discussion and suggestions.

It also seems reasonable that automatic stops should be provided to prevent or control over-wind in high-speed electric hoists.

Your Committee would be pleased to have this question discussed and to receive your suggestions.

Fire Protection

There is a great lack of uniformity and safe practice as regards the building of structures over or near mine openings. Certain States have laws requiring that only fireproof structures may be built over or within a certain specified distance of any mine opening. In other States, where such legal requirements do not make it necessary, unsafe practice largely prevails.

Your Committee therefore recommends that good and safe practice, as provided for by the mining laws of certain States, regarding fireproof structures over or near mine openings, should be adopted, and an effort made to have such practice adopted in other States.

Even in the States where laws have been passed for such protection, the laws are not always sufficiently definite and controversy arises between the State Mining Board and operators who wish to economize.

We believe that a careful study should be made of the requirements in States having such protective laws, with the object of recommending to the State Mining Boards what we would consider good and safe practice. We fully believe that these Boards would welcome such suggestions and recommendations from our Congress.

We further believe that a careful study of the ultimate economy secured by providing fireproof structures over and adjacent to mine openings would fully warrant the expenditure necessary to secure such protection. Frequent fires at coal mines, at the most inopportune time, when production is required, indicate that a reasonable expenditure to prevent such fires, is an evident economy in the life and operation of a mine.

It would seem that only persistent education carried on through such agencies as our Congress, and other organizations of like purpose, is necessary to secure these beneficial results.

Standardization of Merchandizing Machinery

It would seem to your Committee, after careful consideration of the matter, that considerable standardization could be accomplished in certain standard equipment and machinery as now provided by manufacturers of such machinery.

In making this suggestion it is not contemplated that requests should be made on manufacturers to produce uniform machinery for certain purposes, but only to provide such machinery with as nearly as possible standard and uniform connecting parts.

We believe that the manufacturers will co-operate with us in our endeavor to standardize such parts, and thereby obviate the great diversity of such connections as now appear on machinery made for the same purpose.

Your Committee therefore recommends that this matter be fully discussed, and that special inquiries should be made from the manufacturers' representatives present at our Standardization Conference, to obtain their views, and if possible, their co-operation in securing the beneficial results from the operators' viewpoint from such standardization.

Cages, Skips, and Dumps

We believe that a careful study of the cages and skips used for hoisting men, coal, and materials, will indicate that there is opportunity for a vast improvement in the safety devices applied to such equipment.

It would not seem feasible to endeavor to secure the adoption of any standards for such devices, so far as their uniformity is concerned, but it would appear practical and highly beneficial to make a study of all such devices with the object of adopting and recommending those which would comply with good, safe practice for the various equipment to which they would apply, and to endeavor to secure the adoption of better and safer devices on such equipment as now marketed and which is not provided with safe appliances. Your Committee therefore recommends a more careful and extended study of this subject.

We believe that there is so much room for general improvement in present day practice, especially among the lines that we have mentioned above, that little opposition would be encountered from the industry in securing the adoption of our recommendations if we will keep them within conservative lines.

We also believe that having secured the adoption of certain improved practices and standards by the industry, that it will naturally follow that further improvement and standardization can be recommended, and will also be adopted. This process of education and improvement go hand in hand, and is a line along which all progress is made in any industry.

Following is a brief of the discussion of the Report of the Sub-Committee on Outside Coal-Handling Equipment by the Chairman of the General Committee:

Discussion of Sub-Committee's Report

Mr. Wilson stated that he was greatly impressed with the valuable contributions in this report, especially those relating to safety, and suggested that the discusion be taken up in the order of the recommendations made by the Sub-Committee.

Mr. Scholz, acting-chairman of the Conference, stated that the first recommendation of the Sub-Committee referred to clearances for railroad cars under tipple structures, and that the Committee made definite recommendations regarding horizontal clearances, but had found it difficult to decide on the vertical clearance due to the varying height of railroad cars.

In this connection Mr. Scholz stated that the Virginian Railway was using 120-ton coal cars, which he believed were 10 ft. 6 in. high, while the Western roads used not only smaller cars, but cars of much less height for the reason that they were of the gondola type.

Mr. Needham did not believe it practical to recommend a standard vertical clearance, on account of the great diversity in the height of railroad cars.

Mr. Wilson spoke at considerable length regarding the necessity for providing proper vertical clearance above loading platforms, and advised that certain Workmen's Compensation Acts require insurance men to de-

termine certain standards of safety in this connection, and he asked the co-operation of the American Mining Congress and others in this direction.

Highest Railroad Cars Determine Clearance of Tipples

Mr. Kiser suggested that his understanding of vertical clearance would be the difference between the fixed tipple structure and the highest railroad cars that would visit a particular mine.

The Chairman of your Committee, in reviewing this discussion, agrees with the latter conclusion, and believes it possible to recommend and adopt a minimum vertical clearance which it would be assumed should be the clearance, as Mr. Kiser suggests, above the highest railroad cars delivered to any particular mine.

Regarding the horizontal clearance, Mr. Wilson stated that he thought the recommendations of the Committee, namely, a minimum of 18 in. between any support under the tipple structure, and the widest railroad cars passing under such structure was insufficient, and it should be at least 20 inches. There seemed to be no adverse opinion to this suggestion and the Sub-Committee will therefore accept this recommendation.

Mr. Scholz stated that the next question for discussion in this Sub-Committee's report was 'clearance for over-wind.' He stated that this was an important matter, due to the adoption of high-speed hoists, especially at large mines, where the cages or skips were likewise of a heavy type, and for this reason a much larger clearance was required for safety than at mines where slow-speed hoists and lighter equipment were used.

Mr. Bright advised that he had visited mines where there was practically no clearance for over-wind allowed, or at best only a foot or two, which he considered a dangerous condition. He therefore considered it important that some reasonable safe clearance for over-wind should be agreed upon.

Mr. Larson was of the opinion that even with adequate clearance for over-wind safety would not be attained without the use of proper safety devices for slowing down, and for preventing over-wind.

Mr. Kiser suggested that such devices for slowing down and preventing over-wind were difficult to apply where the tonnage required at a mine was greatly taxing the hoisting equipment.

Summing up this discussion, your Committee believes that a reasonable minimum clearance for over-wind of at least 10 or 12 ft. is advisable, and will be an additional feature of safety notwithstanding any other safety devices that may be applied.

Mr. Scholz stated that the next subject recommended by the Committee for consideration was fire protection:

Fire-Resistant a Better Term Than Fireproof

Mr. Wilson believed that real fireproofing is a very much over-worked phrase, and is very badly applied in general. He had a great deal of

experience in this connection while in conferences with the National Fire Protection Association, and he advised that practically nothing in the way of building construction is fireproof, and therefore suggests that we would better use the term 'fire-resistant' and 'slow-burning' for another grade of construction. He believed that this important subject needed furthe consideration, and that it would be well to appoint a Sub-Committee from this Committee to make a careful study of this whole subject of fire protection for mine shafts, slopes, and mine bottoms.

There was considerable discussion of this subject, and it seemed to be the consensus of opinion that several types of construction being used to fulfill the requirements of mine laws for fireproof construction did not always answer this requirement, especially after such construction had been installed for some time, and might be damaged by accident or otherwise.

Your Committee therefore would sum up this discussion with the conclusion that no construction is fireproof if it is made up of combustible material, even though such material may be covered with a layer of fireproofing, or fire-resisting material.

Your Committee also agrees with the suggestion that this is a subject of sufficient importance to deserve the further consideration of a special committee, which would make a thorough study of the subject and report back to this Committee.

Mr. Scholz stated that the next subject presented by the Committee for consideration was standardizing machinery.

The discussion of this topic seemed to be wide of the mark, and your Committee can only hope that on publication of the work, more careful consideration will be given to the recommendation by the Committee regarding standardization of certain parts of more or less standardized equipment and machinery.

Mr. Scholz stated that the last subject submitted by the Committee for consideration was cages, skips and dumps, a subject on which he could spend a whole day and then have much left to say. No further discussion was offered on the recommendations of the Committee that certain minimum requirements for safety should be recommended and adopted for cages, skips, and dumps.

MR. SCHOLZ: If there is no further discussion, we will pass to the next paper, which is the report of the Sub-Committee on Underground Transportation, of which Mr. Watts is chairman.

Following is the Report of the Sub-Committee on Standardization of Underground Transportation:

The adoption of standards is a matter of education and leads to safe and economical production and operation for both manufacturer and consumer of such apparatus and equipment as falls within the influence of its prescribed subjects. While we understand that this Committee was authorized to recommend standards covering transportation problems of underground mine operation, yet we believe in view of the experience of other organizations and associations similarly engaged in attempts to standardize certain matters in connection with their work, that better results will be obtained if at present we were to suggest a number of practices that would be known as 'Recommended Practicés' rather than iron bound or fixed standards. We feel that when a standard of anything is adopted, it should be one that all of the members of any association could and would subscribe to.

The Sub-Committee undertakes to submit for the General Committee's consideration Recommended Practices on the following: (1) track gage; (2) minimum track curvature; (3) wheel-base—coal mine-cars; and (4) maximum outside length of car-body; and, in addition to these, to outline the work in connection with details of car construction, which it has in view for early attention.

Track Gage (Recommended practice, 42 inches)

It is well recognized by the Committee that at the present time track gages vary by almost inches from 24 to 48 in. with standard-gage track occasionally in use. They recognize also that 36, 42, 44, and 48-in. gage tracks predominate, and we have ascertained that in installations recently made and contemplated, about 80% of the track to be installed is of 42-in. gage. The Committee realizes the actual necessity of making one gage of track as a Recommended Practice if we are ever to accomplish anything in the way of standards. We realize that mine developments are becoming larger, heavier cars are being used, larger locomotives are required, higher speeds are necessary, all of which tends to economy, and after material deliberation we have decided to make the definite recommendation for a 42-in. gage track, because on this gage can be constructed a standard car which is capable of containing any tonnage from 1 to 5 tons of coal.

Minimum Track Curvature

Recommended Practice—for rooms, not main haulage, 28 ft. radius based on No. 2 track-frog, having an angle of 28° 04′. Having recommended a definite track gage the Committee feels the necessity of recommending a minimum curvature of track. After giving this subject much consideration, and consulting with the manufacturers of track, we find that most consistent minimum curvature that could be established would be that of a 28-ft. radius, which is based on the use of a No. 2 track-frog having an angle of 28° 04′. The Committee realizes that this is seem-

ingly a large step in track construction. It has considered that there will probably be a little increase in cost in the initial laying of track with this curvature. We have, however, considered its relation to the 42-in. gage of track, and to the capacity of cars that must be hauled around the curves. There is, as all engineers realize, a direct relation between track-gage curvature and wheel-base of cars which will permit economy in operation of equipment, economy in track repairs, and a distinct lessening in car derailments, which are in themselves economies.

Wheel-Base of Coal Mine-Cars (Recommended Practice, Minimum 42 inches)

The Committee makes this direct recommendation, because there is a distinct relation, that must be adhered to, between track gage, curvature, and wheel-base. A wheel-base equal to track gage is (1) theoretically correct and practically permissible; (2) it eliminates derailment; (3) increases speed; (4) lengthens the life of cars in service; (5) future operations tends to higher speed and larger capacity cars; and (6) while this is a radical departure from present practice since the early establishment of 26-in. wheel-base, it is realized that these short wheel-bases are fast passing from mines. New features, such as mechanically-handled cars at the face of rooms, the necessity of reducing the cost of operation, all tending towards the use of the larger car, which in turn necessitates the longer wheel-base.

Overall Length of Car-Body (Recommended Practice)

The maximum outside length of coal mine-car body measured over sills—not bumpers—shall be 126 in. In an endeavor to establish a fixed relation between the wheel-base and the length of the car-body, due consideration has been given to the results observed in deteriorating effects of mine-cars in service. It is generally considered that one of the principal channels of deterioration of coal mine-cars comes through the bending of the car-body bottom over the axles when the centers of axles are too close together. This results in the early destruction of the car, and therefore means a heavy repair expense because of this short wheel-base. Therefore it was unanimously agreed that the over-hang of a car-body should not exceed one-third of its total length. This in turn means that the maximum car-body length will be three times the wheel-base, and since the wheel-base has been fixed at 42 in., it is better to state this length of car-body in fixed terms of inches rather than relating it in any way to the wheel-base.

Couplers and Height of Coupler Center

The Committee discussed the advisability of recommending practices for couplers and the height of coupler centers. The discussion developed that the Federal Government had already thoroughly cared for the subject of safety appliances for railways through the Interstate Commerce Commission, and that it was possible in the future that the Government might establish more or less safety appliance standards for mine equipment, so it might be well if the American Mining Congress could anticipate any

action that the Government might take regarding safety rules in mine-car equipment. It was therefore recommended by this Sub-Committee that an automatic coupler should be considered, also that the height of center of couplers, based on 16-in. wheels, shall be 10 in. above rails. A variation 1 in. above and 1 in. below will be allowed to accommodate 18 and 14 in. wheels, respectively. This provides for placing the drawbar under the car-floor instead of above, as is the present general practice.

These subjects will be considered, and final recommendations made by this Sub-Committee at an early date. There are many items involved when considering the height of coupler center before a standard truck can be decided upon, such as wheel diameters, thickness and height of flanges, size of axles, size of boxes, etc. These points should be considered and established in conjunction with the question of type of coupler and height of coupler center.

Industrial Car Manufacturers' Institute (Recommended Practice)

This organization, which is an association of industrial car builders, having already established certain Recommended Practices bearing on the practical as well as theoretical construction of coal mine-cars, has given our Sub-Committee a memorandum of its Recommended Practices that have so far been adopted. It is our understanding that these practices will be enlarged upon from time to time, and will include recommendations covering practices for treads and flanges of wheels, weights of wheels for carrying capacity of cars, diameter for axles, and journal bearings, types of couplers, and so forth.

As the time of this Sub-Committee has been occupied by the disposal of the above definite recommendations, the practices of the Industrial Car Manufacturers' Institute have not been discussed in detail at any of our meetings, but they will be carefully considered by the Members of the Sub-Committee, with the idea of discussing them at the next meeting. For the information of members of the American Mining Congress, a copy of the Industrial Car Manufacturers' Institute's 'Recommended Practices' for mine-car construction is attached to this report.

DATA ON COAL-MINE CARS

Bolts

In construction, bolts of ½ and ¾-in. diameter only are to be used, and lengths shall not vary in multiples of less than ½ inch.

Capacity

Weights of coal to be used in computing size of car-bodies:

Coals.	Cubic Feet per ton of 2,000 lb.	Pounds per cubic foot.
Gas	42	47.6
Low volatile	35	57.1
Anthracite	35	57.1

Car-Bodies (Widths)

The outside width of car-body bottoms (measured inside of belt shall be 6 in. less than track gage.

Factor of Safety

For running gear and under-frame a factor of safety of not less than four to be used.

Irons (Square and Round)

Square and round iron will be limited to sizes varying not less than ⅛ in. thickness or diameter.

Irons (Car-Body)

All kinds of flat irons, including binders, belt braces, and braces, vertical braces, box braces, drawbars, etc., shall be made in sizes varying not less than ½ in. width, nor ⅛ in. thickness.

Lumber Sizes

Where specifications and prints do not definitely state the requirement, it should be considered that sizes given are for sawed material.

If finished material is called for, it is recommended that material furnished shall be of the nearest standard finished size to that called for.

Rating

To determine size of bodies, to be 'water-level full with top of sides.'

Questionnaire for Coal Mine-Cars

(This form approved by the Industrial Car Manufacturers' Institute.)

Questionnaire No..............

Date..............................

Capacity

Bushels.................... Cubic feet..................

Gage of Track........ **Wheel-Base**......... **Size of Axles**..........

Wheels

Diameter........ Style........ Size of journal........

Length

Inside of car....................................
Center line coupling link.......................
Over bumpers.....................................

Height

Car side above rail.............................
Rear end above bottom...........................

Brake

Is brake wanted?............ Style.................. ..
Single or double................................

Brake Lever Handle

On which side standing at rear of car?
Does it pull to right or left?
Show rough outline on sketch on back of sheet.

Bumpers

Style...
Diameter of holes—Top............ Bottom............

Door-Latch

Style.................. On which side standing at rear?

Drawbar

Type....................................

Size of coupling holes................ Make sketch

End Gate, If Required

Lift or swing type.............................

Hitching, if required:

.... (Describe) ....

Track Curvature

In order that cars will operate most satisfactory in ore and coal mines, the following information for elevating the outside rail of track on curve, which is considered general good practice, is given to members to be used when they are called upon to suggest types of track construction. This information is taken from the 'Coal Miners' Pocket Book.'

Degree of curve.	Radius of curve, feet.	Elevation of outer rail, inches.
1	5,729.6	1/3
2	2,864.9	1/4
3	1,910.1	5/16
4	1,432.7	7/16
5	1,146.3	9/16
6	955.4	11/16
7	819.0	13/16
8	716.8	7/8
9	637.3	1
10.0	573.7	1 1/8
12.0	478.3	1 5/16
15.0	383.1	1 5/8
18.0	319.6	1 15/16
20.0	287.9	2 5/16
60.0	100.0	4 1/2
112.9	60.0	4 1/2
180.0	50.0	4 1/2

It is not generally advisable to elevate the rail more than 4½ in., as it is not good practice to attempt to run trips around sharp curves at a high speed. The rule for standard-gage roads (4 ft. 8½ in.) on surface and for speeds of 25 to 35 miles per hour, is to elevate the outer rail ½ in. for each degree of curvature. An approximate rule often given for narrower gages is to make the elevation proportional to the gage based on the amount given for standard gage. Thus, for a 36-in. gage, the elevation would be about two-thirds of the elevation for a 56½-in. gage for the same speed and curve.

The elevations of the outer rail given in the table correspond to the middle ordinates of the respective curves for a chord of 20 ft. Hence, a common rule to determine the amount of the elevation of the outer rail, for a speed of 15 miles per hour for a 3-ft. gage, is to measure the middle ordinate of a string 20 ft. long, stretched as a chord on the gage-line of the outer rail. For higher or lower speeds, make the length of the string proportional to the speed; thus, for a speed of 12 miles per hour use a 16-ft. string; for 9 miles per hour a 12-ft. string, etc. Also the elevation should be proportional to the gage; thus, for a 30-in. gage, use five-sixths of the above elevation, etc.

The general rule is to begin to elevate the rail a short distance before the curve begins, this distance depending on the amount required. It is, however, not always practicable to do this in mine work.

Track Gage

For new track construction and for use of equipment wherever possible, the 36, 42, 48 and 56½in. (4 ft. 8½ in. railroad standard).

Wheel-Base (Length of)

Wheel-base variations to be between 24 in. minimum and 40 in. maximum, and the variations be not less than 2 in. or multiples of 2 inches.

The following wheel-base computation should be followed: The radius of curves over which cars must travel, given in feet, when multiplied by two, gives most desirable wheel-base in inches.

Wheel Diameters

Wheels of the following diameters only to be used: 14, 16 and 18 inches.

Wheel Mounting

In mounting wheels on axles, the wheel gage, which should be measured from throat of flange to throat of flange on opposite wheel, should be ½ in. less than track gage.

Following is the address delivered to Joint Sections of Metal and Coal Mining Standardization Sections of the American Mining Congress, by James Milliken president of the Industrial Car Manufacturers' Institute.

At the request of Colonel Warren R. Roberts, chairman of the Standardization Committee, Coal Mining Section, of the American Mining Congress, I prepared a paper to be read before this Congress. Since attending several of the Standardization Committees' conferences I have been impressed with the necessity of our doing a number of things in a consecutive order, so that the standardization of mining equipment may become an established fact. If you will bear with me for a few moments I want to emphasize a number of necessities of the case.

Standardization Means Economies and Efficiency

You appreciate the real value of standardization. It means economies and efficiency. In order that standards may be actually realized, it is first necessary that we convince the mine operators that the proposed standards are correct, and that real economies will result. In order to do that, in the first place your several Committees must make the same recommendations. Unless this is done, no real standards can be set. This is, I believe, the first real Standardization Congress that has been held,

or in which real reports have been presented, and it will be noted that some of the Sub-Committees' reports are not in line with each other. I want, therefore, to suggest the necessity of having all individual Committee's or Sub-Committees' reports considered by a General Committee before being presented to the Congress, in order that single definite recommendations can be made.

It is not difficult to make recommendations for standard practices, but it is going to be hard to convince all of the members of this organization that the standards recommended are correct, and will result in economies. It is one thing to make standard practices, and another to get members to agree to follow them, and unless this is done there is no value in establishing standard practices. It has been the experience of a large number of associations that the best way to educate men to the use of standards is to introduce theme as recommended practices. This has two advantages: The practice is not compulsory until it is proved correct. When once the correctness of a principal is established and understood, there will be no difficulty in getting members to subscribe to it. It is, therefore, earnestly recommended that all of the suggested standards be adopted first as Recommended Practices, and in order that you may know that members are willing to agree to follow them, it is further recommended that each Practice be submitted to each member in the form of a letter ballot. If your Recommended Practices are correct, your ballots will all be voted for, and when your members vote for them then will they be willing to agree to them.

Mine-Cars Easily Standardized

I am pleased to talk about the practicability of standardizing mine-car equipment for two reasons: (1) because of my association with the Industrial Car Manufacturers' Institute; and (2) because I personally believe thoroughly in the economies of standardization.

The Industrial Car Manufacturers' Institute is really a get-together association of a number of the manufacturers of industrial cars; to procure economical results; promote a spirit of co-operation among its members; provide means for interchange of views effecting industrial car building interests; to provide means for discussion of live topics; to preserve equitable conditions not only in the workshop, but in selling practices; and to standardize designs and specifications and bring about a uniformity in method of inspection, purchase, etc.

Much of the work that has been accomplished by this Institute is the adoption of Recommended Practices in industrial car construction, which will eventually lead to real standardization in construction. About the details of that I will tell you more a little later. Whenever large work is undertaken, or a multiplicity of interests are combined, standardization follows, which inevitably results in many economies. The Master Car Builders' Association was formed about 1872, and a great amount of work has been accomplished by it in the way of standardizing freight-car equipment for interchange throughout the United States. At the present time, practically all of the parts of freight-cars requiring extensive renewal or

repairs are standard throughout the country for the several types and capacities of cars. The result of this is that if a Pennsylvania Railroad car needs a new pair of wheels, or a new coupler, or a new journal bearing, when the car is in Denver or San Francisco, the repair-men at that point make the necessary renewal of the same sizes and kinds of materials that are being used by the owning road. It can be readily realized what it would mean to keep freight-cars running over all this country if every railroad had to keep repair parts for every other company's cars which come into that particular territory. I talk particularly of cars, because they seem to be more apropos of the coal mine-car problem.

Standard Sizes of Steel Products

The question of standardization, however, applies to practically all modern business methods. It applies to steel production, and to the manufacture of almost any article that is generally used throughout the country. Where would we be if pipe sizes, fittings, and treads, were not standardized? We must all acknowledge it would be very inconvenient if electric-light bulbs were not standardized throughout the country. Large department stores have their standards; many order-houses have theirs; and in fact in almost any walk of life standards of one kind or another have been adopted and are in daily use.

While the question of details for freight-cars has been generally standardized, for the construction of industrial car equipment, particularly when gages other than that of the standard-gage railroads are considered, there are really no standards at the present time.

The Industrial Car Manufacturers' Institute is composed of members who build industrial cars. This membership is sub-divided into groups and one of these groups represents the builders of coal mine-cars. One of their particular desires is to standardize, just as far as possible, mine-car construction, for their own economies and in order to produce coal mine-cars that will give the best of service. At the present time there are many hundreds of coal mines in operation which could use cars of exactly similar design, where the operating conditions are practically the same. If a standard car can be adopted to give a maximum service, it will certainly of great advantage to the mine-car operator, because he gets the best car that can be designed, and because these cars and their parts can be made in larger quantities the cost is going to be materially reduced. At the present time there are scarcely any two car-builders or any two engineers who manufacture or design the same type of a mine-car wheel. There is certainly one tread, one flange, and one-weight wheel for a given capacity car that will give the maximum service. At the present time there are hardly any two alike. Some designs are good; some designs are bad; some wheels are too light for the service, and others are so heavy that unnecessary weight is being dragged around. This same feature applies to sizes of axles and journals, sizes and shapes of belts or binders, sizes and heights of couplers, etc., the manufacturer has to make innumerable patterns for castings, innumerable forms for making car irons of many shapes and sizes. In order to supply demands they have to

carry in stock quantities of these many different types and sizes. When these parts are all standardized, and by that I do not necessarily mean simply one standard for all kinds of service and for all operating conditions, but I do mean that there are standards that can be produced that will meet your operating conditions and that will give you many and lasting economies.

Recommended Practices Adopted

Up to the present time the Industrial Car Manufacturers' Institute has adopted Recommended Practices covering specifications for materials that will be used in mine-car construction; a factor of safety for these materials; they all compute the capacity of cars in the way; they all use the same weights for gas coals, low volatile coals, and anthracite coals, in computing the capacity of their cars; they have decided upon the proper size bolts and rivets, car irons, etc., which should be used in cars of varying capacities; they now use a standard specification or, called by a better term, a questionnaire for the purchaser of mine-car equipment; they are prepared to make recommendations covering the best practice for gage or track, curvature of track, wheel-base of cars, wheel diameters, and so forth.

You have a Committee on the Standardization of Underground Transportation which has made a report to this Convention. The members of the Committee had a number of meetings, and have devoted much time and thought to the question of standardization. They have made a few definite recommendations covering new installations. Some of you may have been startled by these recommendations, which are far-reaching. When, however, you consider the real inwardness of the report and the step that it is going to be, I trust that you will all give the several questions your mature consideration. When you do this I feel sure that the recommendations of this Committee will be unanimously adopted.

For the Industrial Car Manufacturers' Institute I can say that we will be glad to work along with your Committees, your operators, your mine superintendents, and your engineers, in the endeavor to establish standards in mine-car construction, which will give to the operators the most efficient and the most economical coal mine-cars that can be produced.

Following is the brief of discussion on the Report of the Sub-Committee on Underground Transportation by the Chairman of the General Committee:

This Sub-Committee was fortunate in having its Chairman present, who read the report and offered the following brief explanation regarding the work of the Committee:

Composition of Committees

Mr. Watts explained that his Committee was composed of men representing the operating branch of the industry, consulting mining engineers, and manufacturers, and that therefore his Committee was quite representative of the industry. He further advised that the Committee had many interesting meetings, and he had discussed at great length all the subjects covered in the report, and therefore the recommendations represented a great deal of earnest thought on this subject.

Mr. Ebe inquired whether the Committee in making the recommendations on track gages had taken into consideration the methods of mining by long-wall system in the northern fields, and Mr. Watts replied that their recommendations were applicable for that system of mining.

Mr. Milliken first called attention to the fact that different track gages were recommended in another Sub-Committee's report than those in the report under discussion, and in this connection pointed out the necessity for co-ordinating these reports. He made the additional suggestion that instead of at first adopting standards, it might be well to submit to the industry 'Recommended Practices,' and in this manner lead up later to standards. He also stated that he did not agree with some criticism that had been offered by others regarding the lack of co-operation on the part of manufacturers to improving and standardizing mining equipment, and he stated that the car manufacturers, and particularly those of coal mine-cars, are looking forward earnestly to an adoption of recommended practices which will eventually become standards. He stated further that the Industrial Car Manufacturers' Institute is divided into groups and one of these groups is devoted to the construction of mine-cars. This group has done a great deal of good work in the way of adopting recommended practices for a good many details. Mr. Milliken advised that if this Standardization Conference would adopt standards, or recommend good practices, the car manufacturers would be glad to follow them.

Work of National Safety Council

Mr. Hall, representing the National Safety Council, advised that the Council was interested in the safety of machinery as well as practices around mines, and that the Council had done a great deal of good work in trying to promote improved and safe practice. He stated that the Council felt it had not had proper recognition by not being given appointments on the Standardization Committees. He thought this was doubtless an oversight, or based on the presumption that the men in the National Safety Council were too busy to attend committee meetings.

He also advised that the Council had arranged with the U. S. Bureau of Mines to secure the services of Mr. C. E. Juraden, who would be detailed to the Mining Division of the Council's work, and are ready to co-operate with our Standardization Committees.

Mr. Kiser closed the discussion by calling Mr. Hall's attention to the fact that the American Mining Congress has a special committee on Safety Codes, which Committee is composed of one member from each of the Sub-Committes on Standardization, and that this Committee was appointed with the intention that it should act in a joint capacity between the various Sub-Committees on Standardization and the National Safety Council, or any other organization interested in this work of Standardization.

Replying further to Mr. Hall's suggestion that the National Safety Council was anxious to co-operate in this work, and to have representatives on our Standardization Committees, we have to advise that the Chairman of your General Committee has had conferences with Mr. Williams, chief engineer of the National Safety Council, on this subpect, and advised him that we were anxious to have its co-operation. However, it seems that the pressure of other matters has prevented them from giving us much assistance so far. It is our earnest desire, however, to have such co-operation, and another effort will be made to secure it.

Recommendations Require Consideration

We wish particularly to call attention to the fact that this Sub-Committee gave first attention to improved and standard practices, and that many of their meetings were devoted to these broader subjects and that in their report they make a few recommendations which should have the earnest consideration of the industry.

The adoption of the practices recommended by this Committee in opening up of new mines, or the resuscitation of old mines would be of very great benefit not only to the industry but to manufacturers also.

MR. SCHOLZ: We will now have the paper on Ventilation by Mr. W. J. Montgomery. [He was not present, but Mr. Rowe of the American Blower Co., who disagreed with most of it, gave a resume. The report has since been revised somewhat.]

Following is the Report of the Sub-Committee on Standardization of Mine Ventilation, signed by Mr. Montgomery:

As Chairman of the Sub-Committee on Standardization of Mine Ventilation equipment, I am pleased to submit the following recommendations, with a view of establishing this important factor of the great mining industry on a higher plane where it rightly belongs.

The suggestions as set forth in this report have not been approved by the various members of the Sub-Committee, but they were taken from letters reecived from the members and other data compiled by your chairman. The general opinion was expressed that there is not much room to standardize fans when they must be built to meet every condition found in the mining field. However, we believe there is a large field before us in the way of presenting mine ventilation data with a view of impressing those in charge of this important work with the great necessity of providing large air-ways and keeping them free from obstructions throughout the life of the mine. This report will deal with recommendations as to fan installation, boosters, air-ways, and velocities.

The following is recommended for fan installations:

1. That for all gaseous mines there should be an auxiliary fan installed with drive complete.

2. That for all non-gaseous mines at least an auxiliary drive should be provided.

3. That the driving power for the auxiliary equipment should be from a different source than that for the main drive, especially so if electric drives are employed.

4. That all fans be made fireproof. No combustible material should be used for the installation.

5. That there be a maximum outlet velocity into the open atmosphere, varying with the water-gauge against which the fan is operating.

6. That there be a maximum inlet velocity to the fan varying with the water-gauge against which the fan is working.

7. That all fans for gaseous, and large non-gaseous mines be so constructed that they can be readily reversed.

8. That fans should not be reversed under any circumstances, unless conditions inside the mine are thoroughly known.

10. That in case of moderate to large capacity mines it is advantageous to the operator to install a permanent fan at the beginning of operation, and that where the fan is not too far placed from the boiler-house, a steam-engine drive is better adapted; this because it is more economical than an electric drive, and because the speed of the fan is more easily regulated. Where electricity is the power employed at a mine with a large fan, we recommend a slip-ring motor in preference to a squirrel-cage type.

11. That if a temporary fan is installed, it should be so placed that the installation of the permanent fan will not interfere with the operation of the temporary one.

12. That all fan installations be equipped with a regular U-tube water-gauge.

Booster-Fans

1. That they are recommended for use in mines where a section is so remote as to become insufficiently ventilated and where a permanent fan on the outside is in use, but we do not approve of the use of a booster fan as the only source of ventilation, that is a permanent fan should be on the outside.

2. That the brattice and booster fan installation be made absolutely fireproof.

3. That a by-pass door be made in the brattice of ample size to permit sufficient volume to pass without going through the booster.

4. That the by-pass door should always swing in the direction of the air current.

5. That the moter driving the booster-fan be provided with an automatic starter.

Air-Ways

With respect to the air-ways, we believe that no mine should be permitted to get into such a condition as to require a water-gage of over 3 inches to ventilate it properly, and as a means to this end we recommend the following:

1. That all air-ways be driven straight, and where changes in direction are necessary, they be made by long radius curves.

2. That an easement be provided at the bottom of the fan air-shaft to enable a change of direction with a minimum of shock.

3. That all air-ways be kept clean and free from accumulations of falls, mine-cars, old timbers, etc.

4. That where overcasts are used, the air-ways over the bridge be of the same cross-section as found in the entries and that an easement be provided on each side of the bridge.

5. That in the interest of both safety and economy the air be divided into several splits rather than forced to travel in one continuous current.

6. That all brattices and stoppings be made air-tight.

7. That the air shall not pass through old workings to new workings.

8. That wherever possible in a mine, air be brought in or discharged from openings at points remote from the fan.

9. That where labor and roof conditions permit, the multiple-entry system be used.

10. That a change in the laws governing crosscuts be enacted permitting parallel entries to be driven 200 ft. or more before a crosscut is made; the ventilation of these entries to be accomplished by means of small auxiliary fans and the air current carried to the face through tubing.

This method will ensure a copious supply at the face at all times, reduce the cost of miking numerous cuts and building stoppings, prevent a vast amount of air leakage and short circuiting, and in turn greatly reduce the volume of air the permanent fan must handle with a corresponding decrease in power consumption.

11. That where stoppings are built, they should be constructed of masonry. Piling of gob material against masonry stoppings should be avoided. Stoppings should be inspected frequently.

12. That the splits should be made close to the intake, and the several branches united again close as possible to the outlet.

13. That there should be a free and unobstructed inlet and outlet for the air. Haulways and hoisting shafts offer too much obstruction.

Air Velocities

In respect to the velocity of air currents, the following is recommended:

1. That the velocity in the main entries shall not exceed 1000 ft. per minute.

2. That the velocity at face of workings shall not exceed 300 ft. per minute.

3. That the velocity in the air-shaft or drift shall not exceed 2000 ft. per minte.

General Conclusions

It is the opinion of your Chairman that a system of educational work should be started relative to the operation and duties performed by mine-fans. There appears to be a woeful lack of data and knowledge of the subject. Hundreds of mine-fans are condemned by their users as well as by many mine inspectors simply because the mine will not pass the air at a reasonable pressure. The fan may have a normal capacity of 200,000 cu. ft. at 3-in. gage, but the mine capacity is only 100,000 cu. ft. at 3-in. gage, hence only 100,000 cu. ft. is obtained at this pressure. The mine acts as a regulator on the fan, therefore, no matter how large a duty is specified for the fan, only 100,000 cu. ft. is obtained at 3-in. gage.

It is a fact that you find many large mines with not over 3 or 4 years' development offering 2-in. pressure for 100,000 cu. ft. The main object of the operator is to get out a big tonnage and the air-ways are often neglected. He will pay a high penalty in the future in the way of power bills and trouble to get sufficient air to the face of the workings. It is the duty of the mine inspector, and those in charge of this important work, to keep a watchful eye on the mine resistance, and demand that large air-ways be provided and maintained at all times. The whole trouble is

due to the fact that many operators think it is cheaper to purchase a new fan than maintain good air-ways. They do not realize that the new fan, which they contemplate purchasing, cannot produce any more air at the given pressure than the old one. The mine resistance is a charactertistic of the mine and has absolutely nothing to do with the fan. The table below emphasizes clearly the importance of maintaining large air-ways at all times:

$$\text{Power varies as } \frac{\text{Perimeter}}{\text{Cube of area}}$$

Size of air-ways.	Perimeter.	Area.	Relative Powers Making Air-way 10 by 10 = 10 h. p.
10 by 10	40	100	10.0
8 by 8	32	64	30.5
7 by 7	28	49	59.5
6 by 6	24	36	128.5
5 by 5	20	25	320.0

It will be noted from the table that if it requires 10 h. p. for an air-way of 100 sq. ft., it will require about 6 times this amount for an air-way one-half this size.

Following is a Brief of the Discussion of the Report of Sub-Committee on Standardization of Mine Ventilation by the Chairman of the General Committee:

The Chairman of this Sub-Committee not being present, the report of the Committee was presented by Mr. Rowe, one of the members of the Committee.

From a reading of the transcript of the proceedings of this session of the Standardization Conference, it would appear that Mr. Rowe did not read the report and then discuss it, but proceeded to take exceptions to the conclusions and recommendations contained in the report. We think that was an unfortunate way to present the paper, as it did not give the members of the Conference an opportunity to obtain a correct understanding of the report of the Committee, or even to understand properly the criticisms of the report made by Mr. Rowe.

Mr. Rowe states that he understood this Committee was to deal with ventilating apparatus, rather than the question of mine ventilation, whereas most of this report dealt with mine ventilation, air-ways, etc. It is only proper to state in this connection that the report of this Committee is in accordance with the general instructions issued to the Committee, and is also in accordance with the policy adopted by the General Committee on Standardization of mining practice and equipment at its first conference in St. Louis. While all Sub-Committees have not always adhered faithfully to this recommendation of the General Committee, it

has been the general policy, and still is the policy, to try to improve mining practice in the larger and broader sense of the term. When this practice is improved and made more uniform, that is Standardization in its best sense; then will follow standardization of equipment and machinery as far as it is practical to standardize such equipment. The report of this Sub-Committee is not only in accordance with the policy of the General Committee, but contains valuable and constructive suggestions, and deserved better attention than it happened to receive on account of the way in which it was presented. This misfortune seems to have prevented any discussion following by members of the conference.

We will close the review of this report by suggesting that the Committee should be organized, as the Chairman admits that he has never been able to secure a meeting of his Committee, and has had to prepare his report from information he gained by correspondence with the members.

Report of Sub-Committee on the Standardization of Mine Drainage, signed by George R. Wood:

In regard to Standardization of Drainage Apparatus for coal mining, I have written my Committee members as to their views, and regret to report an almost total lack of constructive suggestions as to possibility of any appreciable measure of uniformity in design, construction or aplication of such apparatus. This appears to follow from a belief that requirements are specialized to a degree, similar to ventilating appaartus. I have been able to talk personally only with Mr. Knight, of Kayford, W. Va., and the recommendations following may be taken therefore as our joint position in the premises:

Safety

All gears to be enclosed or completely guarded.

No projecting keys or set-screws to be used on revolving parts. Self-oiling bearings recommended wherever possible.

Enclosed motors preferred.

Motors up to 7½ h. p., a. c. or d. c., should be self-starting, with enclosed switch.

For larger motors, enclosed rheostats or compensators are preferred.

Voltage not exceeding 250 d. c., or 220 a. c., recommended for underground work, except for large motors (over 150 h. p.) where 440 a. c. is recommended, in which case, as with 500-volt d. c. system conduit wiring is urged.

All gears to be enclosed or completely guarded.

Design

In plunger or piston pumps, the only stock pumps manufactured appear to be small gathering pumps, usually 30 to 60 g. p. m. capacity, against varying heads not exceeding 100 ft. Each manufacturer, not unreasonably, objects to any modification of his design. We believe, however, that we should recommend that these pumps should be built as standard for 100 ft. head instead of 30, 60, etc. Motor horsepower should be double the theoretical horsepower of pump capacity. Pinions should be of fiber, leather, or paper to reduce vibration injurious to motor windings. We do not favor present tendency to large valve areas in these pumps to reduce friction, since the power consumption is usually negligible, and would prefer less area with higher velocity and higher valve-lift to ensure passage of solid particles through the pumps instead of stopping under the valves. This idea, however, is at variance with that of most designers, and needs discussion by those interested.

Construction

This detail does not seem to require our consideration, for the reason that there are numerous builders of satisfactory, efficient, and rugged pumping machinery of all required types, and we believe the (temporarily) obsolete law of supply and demand will again function to eliminate the unfit.

We would recommend merging this Committee with that on Ventilation, as a simplification of the General Committee work, and because of the limited field, as we view it, for standardization in pumping or drainage.

Review of Report by Sub-Committee on Standardization of Mine Drainage by the Chairman of the General Committee

I am constrained to make the following comments on the Report of our Sub-Committee on Mine Drainage for the reason that I disagree with the introductory paragraph in the report of this Sub-Committee. The members of this Committee seem to have an entirely wrong conception as to their duties. I draw this conclusion from their statement:

> "And regret to report an almost total lack of constructive suggestions as to possibility of any appreciable measure of uniformity in design, construction, or application of such apparatus."

This statement indicates that this Committee was endeavoring to simply standardize mine pumps instead of trying to improve the practice regarding mine drainage. Anyone who is familiar with the drainage of the great majority of coal mines in this country will appreciate that there is ample opportunity for such improvement. It seems to us that this Committee could find a large field of usefulness by preparing a constructive program for the drainage of coal mines. This program should include instructions for the drainage of the mine along modern and

economical lines, and should include all the general specifications required for the proper carrying out of such instructions. These specifications should cover in general the drainage equipment required, together with the proper method of installation, operation, etc.

The efforts which were already put forth by this Committee, as indicated by their report should follow such a program as suggested above, and not precede it, as the suggestions contained in their report relate only to details and not to the large constructive features of the improvement in standardization of mining methods and equipment. It would therefore seem to the Chairman of your General Committee that if this Sub-Committee does not approve of the method of approaching this work, as outlined above, that in order to harmonize the work of this Sub-Committee with that of the other sub-committees in the Coal Mining Branch, that this Sub-Committee should be reorganized with this object in view.

Adjournment.

METAL MINING SECTION, STANDARDIZATION COMMITTEE

American Mining Congress

PRELIMINARY COMMITTEE MEETINGS, NOVEMBER 14, 1920

Mr. Chas. A. Mitke presided.

The meeting was opened by the Chairman presenting a brief outline of the possibilities of standardization in metal mining.

Inasmuch as the majority of those present were interested chiefly in the work of the Sub-Committee on the standardization of drilling machines and drill-steel, the discussion that followed was confined principally to this subject.

The question was raised by the Chairman as to whether, if the work of the Committee was directed towards investigating the limits of weights of the various types of machines that have proved most satisfactory to the majority of users, the results would prove of material benefit both to the manufacturers and operators. It was pointed out that at the present time there are a great many machines of each type on the market—such as Leyners, stopers, and jackhamers—with but slight variations in weights, the difference in some cases not being more than a few pounds, or in special cases not more than a few ounces.

In this connection some interesting statements were made. Mr. Leonard, president of the Denver Rock Drill Mfg. Co., mentioned that members of the mining profession probably do not realize the enormous amount of money a company must spend to perfect a new machine.

Cost of Placing New Drill on Market

Mr. Bayles, chief designer of the Ingersoll-Rand Co., remarked that it cost the manufacturers $100,000 to perfect a new drill and place is on the market.

From the discussion which followed, it appeared that if the number of different types of machines could be reduced to a minimum, it would be of material benefit to the manufacturers as well as to operators.

One of the difficulties mentioned was the great variety of air pressures available in the different mines; also that certain companies demand that machines be built to conform to their own particular specifications. This procedure naturally results in a great variety of machines.

A discussion then fololwed on the possibilities of the operators getting together and standardizing their conditions; that is, classifying the various kinds of ground met with in metal mines, agreeing on uniform air pressure, systematic lubrication of machines, etc.

It was repeatedly pointed out that if hose connections, various minor parts, such as bolts, threads, etc., and possibly, chucks, were standardized, this would be of great convenience to the operator. Not only could these minor parts be interchanged on the various makes of machines, but if the chuck of the jackhamer were made to correspond with that of the stoper, steel would then become interchangeable.

Meeting of Sub-Committee on Drilling Machines and Drill-Steel

NOVEMBER 16, 1920

The general chairman, Chas. A. Mitke, presided.

MR. MITKE: We are fortunate in having with us Mr. Norman Braly, manager for the North Butte Mining Co., who has done a great deal of work in standardization, and as the Committee on Drilling Machines and Drill-Steel, of which he is chairman, is just getting under way, we would like to have him tell us something about the work that has been suggested and what the Committee proposes to do.

Mr. BRALY: I suppose few of us realize that there is no machinery manufactured in this country which penetrates foreign markets as far as rock-drills. I say this because the work of standardization in rock-drills will necessarily be slow, and it would be a mistake to rush into this matter. That is the danger of standardizing this type of machinery.

Three Well-Known Types of Drills

During the last 20 years there have been three large drill-manufacturing companies in this country. Each one has carried its own standard weight; each one has a record of which it is proud; and I understand that it will be hard to get them to adopt all the standards. However, there are a few things that it would seem to me they could do to benefit the mine operator here in this country. It is understood that when a mine operator purchases a machine, he generally strips it of all trimmings, after which he puts on standards of his own, and send it underground, otherwise, if he gets it underground it will not fit. We have asked the Sullivan Machinery, Ingersoll-Rand, and Denver Rock Drill companies if it would not be possible for them to get together and create standard hose couplings and standard nuts on the machines, so that when they are sent underground they will go into place. As it is now, there is a great deal of lost time from men going underground and having no standard wrench to fit the machines, and they have to hunt all over the mine for a new part or something of that kind; and we believe that there are a few simple things that can be taken up at first and standardized, which will help us greatly.

Each of these drill manufacturers have consented to appoint a man to a committee upon which there will be three or four members of the Sub-

Committee of the American Mining Congress on drilling machines and drill-steel. This inner committee, consisting of probably eight members, will see if some standards cannot be worked out; also the other members of the drilling Committee—of which there are a large number—will also give us their co-operation. I believe this is the simplest way to go about it.

Mine Operators Can Not Design Drills

I do not believe that the mine operators themselves are capable of designing these machines, or even specifying exactly what can be done with them. I think we will have to leave that to the manufacturer. I really believe that if we leave this matter to the manufacturers they will work out this standardization, and in that way help the operators.

MR. MITKE: Mr. Arthur Notman, who is one of the members of the Drilling Committee, has prepared a paper which he will now read to us, after which a general discussion will follow.

MR. NOTMAN: Perhaps a word of explanation as to how we made this investigation might not be out of order: Just prior to the outbreak of the war, we had been engaged in an attempt to standardize on one size of steel—of one section—for use in drifting machines, plungers, and stopers; but during the war we had to abandon our experiments. As soon as conditions allowed, we started again. In the meantime we had made a great deal of progress, as we feel, in the matter of standardizing on methods of driving headings. In the matter of standard rounds, timbering, and so on, most of you who have seen Mr. Mitke's papers on those subjects have some idea of what was done in that respect at Bisbee.

Having partly decided upon methods, we felt the next step was to take up the matter of equipment, and for the past year we have had our engineering office engaged in this work, and this paper has been prepared under my direction by Mr. L. M. Cummings, one of the engineers in our office, who has actually been operating machines himself and has first-hand knowledge of the information included in the paper.

We have compiled a good many tables concerning sizes of bolts, nuts, pipe-threads, and so forth, which it would be hardly worth-while attempting to read, but I believe arrangements can be made whereby the members of the Committee and others who are interested, may read the paper in printed form later on.

[Mr. Notman's paper will be found on page 729 of the Proceedings.]

MR. MITKE: We are certainly indebted to Mr. Notman for working out such a complete paper, and it has opened a real field of discussion and thought. I feel quite sure that all of you who are interested in drilling will learn of a number of interesting things which will be worked out under Mr. Notman's direction within the next year or two.

Limits In Steel and Drill-Bit

There is something that I would like to ask, and that is just when may we expect to reach the limit in decreasing the size of the steel and the size of the drill-bit—that is, the limit at which speed will stop increasing, as it should, theoretically? I should like to call on Mr. Notman; I have heard so many different opinions, claiming that so far we have not as yet reached the limit, but as a matter of fact are a long way from it. I think that Mr. Notman's figures and his opinion will throw a lot of light on the subject.

MR. NOTMAN: The opinion that I started off with was that while reducing the size of the steel we should hope to obtain something like a theoretical increase in drilling speed, due to the smaller area of the round cut; but we discovered that the relative power of the machine and the size of the steel interlocked so that we did not get a theoretical increase in drilling speed, when you reduced the size of the steel for which the machine was probably designed. and I am not prepared to offer any information on that subject. The limiting factor, if any, so far as the operator is concerned, is the question of minimum size hole in which you can get sufficient powder to do the work. Of course, it is desirable to concentrate the powder at the bottom of the bore-hole as far as you can, and the inherent desire in the miner for a big hole, in order to get further down there, is pretty hard to overcome. They offer that as an objection to the use of 1-in. steel in drifting; but, on the other hand, they have never complained at all to the use of ⅞-in. steel in raising or stoping conditions, where the importance is not as great as it is in drifting. I think perhaps some of the drill-men could tell us about the proportionate condition of the drill and the size of steel. I would like to add that as a matter of fact, we have been using ⅞-in. hexagon steel with a small bit, for the stopers, and the work done by one of these modern high-speed stopers is just exactly as severe as it is in the case of a drifting machine. The foot-pound pressure is less, but the actual work done on the steel is a little more, I think, in the case of the newer stopers than drifting machines. They have been making exhaustive experiments on this point.

MR. BAYLES: We have found that it depends largely on the air pressure and hardness of rock with some of the present day drills. Steel becomes bent, and you cannot afford to have bent steel; drilling falls off often 30% by a slight bending of the steel. In fact, if some of the bent steel is examined you would not notice that it is bent; but if you tested it, it will fall short 20%. Line it up, and you find that it is bent. Take the same steel and straighten it out an the anvil and sharpen it, and you get 20% more drilling. I have never been able to understand why that should make steel drilling fall off so much; but it does, invariably.

MR. MITKE: Mr. Walsh, is it possible for you to give us just a brief summary of some of Mr. G. H. Gilman's ideas, or would you have to give practically the whole paper?

[Mr. Walsh then read Mr. Gilman's paper, which views the question from the standpoint of a manufacturer, appears on page 721 of the Proceedings.]

MR. JOHN KIDDIE: I might state that we made some tentative experiments in which we found that the amount of power necessary to drill the holes depended on the area of the hole, that is to say, the area of the bit. Mt. Notman seems to be of the opinion that you could reduce the size of the hole so as to get powder enough in there (perhaps, if necessary, using stronger powder), that is to say, you could get powder into a smaller hole to break the ground, provided you can drill it with the size steel, that is, by hand bit. It is not possible to improve the grade of the steel so that you could use a smaller steel and not have the successive break.

MR. WALSH: The point that Mr. Notman made was that they get better results in some cases with the bigger steel and bigger hole.

MR. KIDDIE: Yes, my notion was that perhaps the big drifting machines were too powerful for the size of the hole.

MR. WALSH: I would imagine with the bigger machine and the smaller gage and the smaller steel you could get more penetration, and it would affect your rotation so that you could cut down your drilling speed. Where you use the larger steel it would fit in to better advantage. Putting same energy into the same machine and using a lighter blow, with not so much penetration but a faster rotation, and you might get different results. As you said, you might use the wider machine with the smaller steel and get the same results.

MR. NOTMAN: We found that with the 18 Leyner, cutting down from the 1¼ in. to the 1 in., we got practically the theoretical increase in drilling speeds, but when we went to the heavier machines—the 248 Leyner, or the D. X. 61—you do not get that increase.

MR. BAYLES: There are two things that occurred to me which I wished to ask Mr. Notman: He speaks of including in the supplies a box-wrench to pull out the steel: Did he mean by that that the maker should carry 8 or 10 different types of chuck-wrenches, each with a different size box-wrench in it?

MR. NOTMAN: That is exactly what I meant. I did not intend to put the burden of the supplying of those wrenches upon the manufacturers. We make our own wrenches, and probably will continue to do so.

Use of the Box-Wrench

In saying that we wanted to use this box-wrench for pulling out steel, it often happens that a drill cannot be withdrawn readily when run down, and if a man had a box-wrench which would fit behind the steel, a slight turn of it would free that steel and he could withdraw it. The practice is to take a monkey-wrench and stick that behind it, and twist and pull at

the same time. It is not for extracting steel that is stuck in the ground but simply steel that cannot be slipped out of the machine readily to withdraw it. I think such a wrench could be made to fit any one of these sections, either a big chuck-wrench or a smaller one. What we want is two double-ended wrenches to fit all the parts which are ordinarily used.

MR. WALSH: Mr. Notman's paper represents a lot of work, but there seems to be several things that perhaps do not agree. You talk about making side-rods and standardizing them at $\frac{5}{8}$ in. That may mean changing all drop forgings, and a changing of dies, which are extremely expensive; perhaps it means changing the G-bolts. While I am not attempting to throw cold water on the idea, these things are to be considered from the manufacturers' standpoint on machines already in the field. It might throw a big burden on the manufacturer.

MR. NOTMAN: I think that is an important point. It would not throw the burden on the manufacturer alone from the fact that all the users are equipped with drills which have been turned out and not one of us can afford to scrap anything useful. It is something that we cannot hope to effect over night, but if it were a basis for future designing, I think we have accomplished a great deal.

MR. BAYLES: Mr. Notman suggests in one part of his paper that the nuts on the standard rods should be square, while in another he recommends a $\frac{5}{8}$-in. bult with a standard rod and hexagon nut. Is that correct?

MR. NOTMAN: I do not know that there is any particular choice in the matter; I believe that either one would be satisfactory.

MR. BAYLES: Being one so easy to get at, I think that a hexagon nut would be better on account of not having the sharp corners of the square nut. I think the hexagon nut is used today.

In Mr. Gilman's paper it is said that the minimum weight of a jackhamer is 25 to 30 lb. on the ground. I do not think it is practical to manufacture a serviceable jackhamer much under 30 lb. There have been jackhamers on the market around 201 b.. for many years, but they do not appear to be successful, even if one foreign jackhamer that I have seen only weighs 10½ lb. That I think is rather light.

MR. MITKE: Yes.

MR. BAYLES: There was one of 19 lb. on the market for a while before the war—I do not know how it is since—and it was very good, but of course it would not compete with the bigger tools; but for its purpose it is very satisfactory. We have one of 20 lb. which has a big demand.

MR. NOTMAN: I think it is important not to lean backwards in attempts to standardize on designs. I think that is absolutely agreed. Any question of standardization that does involve details of design should be given careful consideration. I think that also applies to the question of weight of the machine. You can never tell until you have tried it

whether you can get by with a machine weighing a third less than the machine you are using.

MR. BAYLES: No; the natural law of supply and demand governs weight of machines, without our doing it here.

MR. MITKE: What weights of small machines are in greatest demand?

A MEMBER: There are more 40 or 45-lb. tools sold, though a 50 or 60-lb. tool will do more work.

A MEMBER: I think Mr. Notman's conclusions regarding the weight of the drill and stand-up answer that question very well.

MR. BAYLES: It would be foolish for us to determine the weight of the tools for certain work now, because we know that five years ago we had an idea that certain work required a 200-lb. tool, which today is performed by a 50 or 40-lb. tool, and two years from now somebody may be doing it with one of 10 pounds.

MR. MITKE: The changes are certainly remarkable. Take one mine where they considered that the 18 Leyner was the only machine to drill the ground, and today they just use the jackhamer and drill it the same as they did then. That change was made in an entire mine within a year or a year and a quarter, so we cannot help being conservative when we consider the future. Nevertheless, it is interesting to forecast as near as possible what might be the demand, and what the general trend will be.

A MEMBER: I think that the trend is more for light machines. The very fact that they are reverting to lighter steel means that they must place their holes in the proper position and get the powder distributed properly; rather than drill a few large holes, they should drill more small ones and get them properly placed. Such is the secret of the light drill, and that is why it is becoming more popular. I think it will be carried even further; the tendency is for a lighter machine.

A MEMBER: Though for shaft sinking, for instance, we will have to use a heavier machine.

MR. BAYLES: But still much lighter.

A MEMBER: I am wondering if the mining companies, in trying to get the results we aim at, and in placing so much burden upon the rock-drill itself, whether they are looking into the drilled steel and also their explosives. I think both should be studied. We can get more powerful explosives, and we can drill smaller holes—that will be increased efficiency all around—and also get a bit that will last longer.

MR. MITKE: I think that it is only a question of time now.

A MEMBER: Many times they make a comparison in different mines, but in some they do not take into account the condition of the drilling bits. . They report so many feet drilled in a given time. Possibly the difference is entirely due to other than the machine itself. The Copper

Queen is the only mine that looks at a drilling bit to determine how dull it is.

MR. NOTMAN: In justice to the drill manufacturers,I would like to go on record as being of the opinion that the design of the machine, and the work that the machines are doing, have improved much more than the steel that is used in the machine, and the general routine of operations through which the machine is put. There is no doubt about that. Our activities should be directed not towards changing the designs of the machines, or attempting to dictate what the designs of the machines should be, but to see that the fittings which are used in the routine operation of drilling are so designed that the manipulator can use them to the best advantage.

Sub-Committee on Standardization of Mine Timbers

Mr. Chas. A. Mitke presided.

CHAIRMAN MITKE: Mr. Norman Carmichael, general manager for the Arizona Copper Co., and chairman of this Committee, has found it impossible to attend, but has sent his deputy, Mr. John Kiddie, superintendent of mines for that company in his stead.

[Mr. Kiddie explained that while considerable work had already been accomplished, such as the compiling of data from 17 large companies, the Committee did not feel that it was yet in a position to make a complete report; and it was the desire of Mr. Carmichael that more time should be allowed the Committee in order to investigate the subject more thoroughly and be in a position to submit a report at the end of the coming year (1921).]

Sub-Committee on Metal Mine Ventilation

Mr. Chas. A. Mitke presided.

The following members were present: A Stoddard, D, Rait, Robert Bell, and W. A. Rowe.

A preliminary questionnaire, to be sent to operators in order to obtain sufficient information to constitute a working basis, was presented to members by the Chairman, and the various points embodied in this questionnaire taken up and discussed.

It was agreed that the principal avenues to be followed by this Committee would be the investigating of conditions in underground working places, with the idea of establishing a standard mine atmosphere. It was also hoped that the Committee—which is composed of both operators and manufacturers—might work out a set of recommendations for different kinds of standard ventilating equipment, which would thoroughly ventilate the so-called dead-ends in drifts, raises, and stopes.

Sub-Committee on Mechanical Loading Underground

Mr. Lucien Eaton is chairman.

In the absence of Mr. Eaton no meetings were held, but the Chairman reported that a questionnaire is being prepared which will be sent to all Committee members, operators, and manufacturers of underground power shovels, in order to compile sufficient information to constitute a working basis.

Sub-Committee on Steam-Shovel Equipment and Operations

Mr. H. C. Goodrich is chairman.

In the absence of Mr. Goodrich, no meetings were held, but the Chairman reports that a questionnaire is being prepared, which will be sent to all operators and manufacturers of steam-shovel equipment.

Sub-Committee on Underground Transportation

Mr. Wm. B. Daly is chairman.

In the absence of Mr. Daly, no meetings were held, but it is understood that a questionnaire has been prepared which will be sent to all Committee members and operators in districts not represented by Committee members.

Sub-Committee on Fire-Fighting Equipment

The General Chairman, Mr. Chas. A. Mitke, presided.

CHAIRMAN MITKE: Mr. Connibear, chairman of this Committee, has found it impossible to attend the meeting, but on behalf of his Committee, has forwarded a preliminary report, which I will ask Mr. Guy Johnson, a member of this Committee, to read for our benefit.

MR. JOHNSON: (Reading the report):

A canvas is being made to ascertain the amount and variety of fire-fighting equipment that metal-mine operators are using. To obtain this information, copies of a questionnaire on Fire-Fighting Equipment were distributed. The length of time since the organization of this Committee was perfected has not been sufficient to reach operators in remote parts of the country.

The number of questionnaires that have been received by the Committee from the operators of copper and iron mines in the Lake Superior district is sufficient to present an adequate report of this district; but with this exception, but few reports have been received. Data is not available at present from the other important districts, due to the delay in transmission of the same.

Mine Rescue Apparatus

The value of rescue apparatus in fighting mine fires, and especially when lives are in danger, is universally acknowledged. The activities of the U. S. Bereau of Mines have extended into all mining districts, and have demonstrated that oxygen rescue apparatus must be accepted as an essential part of a mine fire equipment.

At the present time, apparatus used in this country consists of four types; the Fluess, the Gibbs, the Paul, and the Draeger. The Draeger, however, is slowly but surely being replaced by the other types.

An attempt to standardize on a particular apparatus will not meet with the approbation of mine operators. Attention should be directed to the advisability of using an apparatus that meets with the general requirements as recommended by the Bureau of Mines in Technical Paper 82, pages 23 and 24.

Mine operators of the Lake Superior district have approximately 150 machines. A report of the conditions of these machines for the past two years, recently issued by the Bureau, indicates that action for improvement is recommended. This applies not only to the apparatus, but more particularly to the training of employes in the use of them.

Mechanical Resuscitation Devices

This apparatus is not now accepted with the high degree of favor as it was a few years ago. More attention is being given to manual methods. Not only is the effectiveness of mechanical devices questioned, but the probability of delay in obtaining a machine immediately when needed reduces the chances of resuscitating an unconscious person.

Fire Extinguishers

These are being installed underground—both the carbon tetrachloride and the soda-acid types. Objections have been raised to their use. Increased use of electricity as a motive power for haulage, hoisting, and plumbing has resulted in the adoption of the tetrachloride type for extinguishing electrical fires in incipient stages. Additional information is imperative before any conclusions can be deduced.

Fire-hose

Very few mines, compared to the total number operated in the metal districts, have adequate underground fire-hose equipment. In the questionnaires that have been returned, only one mining company has adopted this method in a comprehensive way.

Portable Blowers

There are mining companies that resort to the portable blowers as an effective method of fighting underground fires, but the Committee has not yet received information from those companies which are known to have made the most advanced strides in this direction. Many mines have blow-

ers installed to improve ventilation, and they report that they are available for fire emergencies. Adjustments are necessary, and the delay that will follow thereby is not known at the present time.

Bulkhead Material

Many companies report maintaining posts, planks, and sand for bulkhead purposes. Due to the large volume of humidity, which is common in the atmosphere of many mines, cement is not stored underground. Other operators report that substantial bulkheads have been provided in order to ensure the safety of mines in case an unexpected volume of water is encountered, and that they can be utilized to advantage in limiting a fire-zone.

Fire Protection at Collar of Shafts

The use of iron doors and spraying systems at collar of shafts have been adopted by a few operators; others report that steel head-frames and concrete shafts eliminate fire hazards, and that these agencies are not necessary. Most operators, however, have not recorded themselves relative to their value.

Stench System of Alarm

This system of alarming underground employees when a fire occurs has been adopted by several large operators, and its affectiveness is reported to be very satisftactory.

Conclusion

Additional information is absolutely necessary before the Committee can record its recommendations. This will require more time than was at our disposal this year. An effort will be made to enlarge the membership of the Committee so that further delay in obtaining desired information may be overcome.

STANDARDIZATION

ORIGINAL PAPERS PRESENTED AT THE TWENTY-THIRD ANNUAL CONVENTION OF THE AMERICAN MINING CONGRESS, DENVER, COL., NOVEMBER 15-20, 1920—STANDARDIZATION SECTION

JOINT REPORT OF SUB-COMMITTEES ON STANDARDIZATION OF UNDERGROUND POWER TRANSMISSION AND STANDARDIZATION OF POWER EQUIPMENT

Submitted by K. A. PAULY and A. B. KISER, Chairmen of the Sub-Committees on Power Equipment and Underground Transmission

On account of the intimate relationship between power transmission and power equipment, workable standards in these two fields can be developed only through closest co-operation between those interested in these two phases of the general problem of standardization of mining equipment. Appreciation of this fact from the first, lead the Chairmen of Sub-Committees No. 3 (Underground Power Transmission) and No. 7 (Power Equipment) to hold their meetings jointly. Not only did this procedure permit of the closest co-operation between the two Committees, but gave each the benefit of the experience of the members of both.

We wish here to express our appreciation of the keen interest shown by the members of our Sub-Committees and the valuable assistance which they afforded us by their constructive suggestions concerning many of the perplexing problems. We are also indebted to the United States Bureau of Mines for providing us with a meeting-place and a secretary during our meetings.

Two joint meetings were held at Pittsburgh on May 20 and 21, and October 19 and 20.

Those present at the first meeting were: Messrs. R. L. Kingsland, R. Kudlich and L. D. Ilsley, representing O. P.

Hood, Graham Bright, R. W. Moore, A. L. Nicht, F. L. Stone, A. B. Kiser, Chairman of Sub-Committee No. 3, and K. A. Pauly, Chairman of Sub-Committee No. 7.

Those present at the second meeting were: Messrs. R. L. Kingsland, R. Kudlich and L. D. Ilsley, representing O. P. Hood, Graham Bright, A. J. Nicht, A. B. Kiser and K. A. Pauly.

In considering the problem of standardization, we have divided it into two parts—the standardization of equipment, and the standardization of practice in the installation and operation of equipment.

As the Electric Power Club has for its object the standardization of the capacities, voltages, speeds and essential mechanical features of electric motors, generators, transformers, etc.; and as its standards are accepted throughout the country, it was suggested that we adopt them as our standards of equipment. It was also suggested that the standardization rules of the American Institute of Electrical Engineers be adopted as our standards of technical matters.

With the standardization of equipment disposed of, we devoted our time and attention to the standardization of practice. This field has been thoroughly covered by the Bureau of Mines in its Technical Paper No. 138, entitled 'Suggested Rules for Installing and Using Electrical Equipment in Bituminous Coal Mines,' and these were taken as the basis of our work. Each rule was thoroughly discussed and revised where it seemed advisable to do so, for the purpose of clarifying it, or making it conform to present-day practice.

The rules as modified at our first meeting were sent to each member of both Sub-Committees, with the request that they act as chairmen of local committees and obtain suggestions as to further modifications from the engineers in their respective districts. This brought many valuable suggestions from the districts that were not represented at the Pittsburgh meeting.

The suggestions obtained in this way were circularized and thoroughly discussed at our second meeting, and a final draft of the suggested rules made.

It has been impossible, with the time at our disposal, to devote as much attention to some matters as we would like to

have given them before submitting our report, but it is felt that the best results can be accomplished by submitting the rules in their present form.

The rules as they appear in Technical Paper No. 138, and as modified by our Committees, cover coal-mining conditions, but they are applicable to metal mining by omitting those paragraphs that apply to the existence of gas or coal dust in explosive mixtures.

We therefore submit the following as the joint recommendations of the Sub-Committee on Underground Power Transmission and on Power Equipment:

That the standards of the Electric Power Club be adopted to our standards of electrical equipment:

That the standardization rules of the American Institute of Electrical Engineers be adopted as our technical standards; and

That the following rules be adopted as our standards of practice in the installation and operation of transmission and power equipment:

Basis of the Rules

Five basic measures for safeguarding the use of electricity in mines are as follows:

1. Remove the contributory causes of accidents or danger.
2. Remove from the vicinity of electric apparatus all elements susceptible to the influence of electricity.
3. Keep the electric current where it belongs, if possible. If not, limit the area of its activity by protective devices.
4. Use a large factor of safety in the selection, installation and inspection of equipment.
5. Have full control of the movements of electrically driven machines.

Each rule that is given in this report is proposed as necessary or helpful to the accomplishment of one or more of these measures.

Definitions of Terms Used

The meanings of some of the terms and expressions as used in this report are defined below in order to avoid confusion:

Alive

See definition of "live."

Approved

This term means accepted as suitable by a competent committee, board or organization designated by those adopting the rules.

Authorized Person

A person appointed or permitted by the official designated by the State mining laws as the one in charge of the operation of the mine to carry out certain duties incident to the generation, transformation and distribution or use of electric energy in the mine, such person being one who is competent within the purpose of the rule in which the term is used.

Electric System

This includes all electric apparatus pertaining to the operation of the mine, and under the control of the mine officials, which is connected electrically to a common source of voltage or which is installed so that it can be thus connected.

Grounded Circuit

A circuit that is permanently grounded at one or more points.

Grounding

As applied to any object used in connection with a permanently grounded electric system, this term means connecting such object to the earth in such a way that a path of low resistance is provided between the object and the permanently grounded point of the system. A connection to a thoroughly bonded rail is an example of a good ground connection.

Grounding, as applied to any object used in connection with an electric system that is not provided with a permanent ground, means making connection to the general mass of

earth in such a manner as will ensure at all times an immediate discharge of electrical energy without danger.

Ground Return

That part of a circuit which is the earth, or metallic conductors intimately associated with the earth, and which is practically at earth potential at all points, is a ground return.

Live

The word "live" means electrically connected to a source of voltage difference, or electrically charged so as to have a voltage different from that of the earth.

Permissible Equipment

This refers to any equipment that is listed with the United States Bureau of Mines as permissible for use in such places as containing gas or coal dust in explosive mixtures.

Portable Electric Lamps

Electric lamps that may be carried about while lighted are portable. This general term includes lamps operated by batteries and lamps connected to a source of power by a flexible conductor, whose length limits the range over which the lamp may be used.

Self-contained Portable Electric Lamps

Electric lamps that are operated by an electric battery, which is designed to be carried about by the user of the lamp, are self-contained.

Portable Motors

Motors that are intended for service here and there as occasion requires, and that are so constructed or mounted as to facilitate moving them from place to place, are termed portable.

Stationary Motors

All motors not included in the class of portable motors shall be considered as stationary motors.

Potential

The words "potential" and "voltage" are synonymous, and mean electric pressure.

Difference of Potential

This expression means the difference in electric pressure existing between any two points in an electric system, or between any point of such a system and the earth, as determined by a voltmeter.

Potential of a Circuit

The potential or voltage of a circuit, machine, or any piece of electric apparatus, means the voltage normally existing between the conductors of such circuit or the terminals of such machine or appartus. In alternating current systems the voltage of the system shall be that indicated by a voltmeter.

(a) Any voltage less than 301 volts shall be deemed a low voltage.

(b) Any voltage greater than 301 volts, but less than 651 volts, shall be deemed medium voltage.

(c) Any voltage in excess of 651 volts shall be deemed a high voltage.

Protected

This word when applied to the current-carrying parts of an electric system, means that accidental contact with such parts is prevented by approved guards.

Shock-proof

As applied to the current-carrying parts of an electric system, excepting trolley wires, this term is taken to mean that contact with such parts is prevented by the use of grounded metallic coverings or sheaths.

Generating Station

A station in which electric geenrators are operated by prime movers.

Sub-station

A station in which the current is changed in character or voltage.

Underground Station

A place underground in which there are transformers, switchboards or electric machines other than portable motors, or any one of them.

Switchboard

The essential mounting common to several pieces of switchgear or controlling appliances.

Voltage

See definition of "potential."

DIVISION 1.—GENERAL RULES

Man in Charge of Electrical Equipment

1. At each mine where electricity is used underground, there shall be in charge of the electrical equipment a man fitted for his position by ability, training and experience. The character of the equipment will determine the qualifications of the mine electrician, and he shall be thoroughly familiar with the operation and maintenance of the equipment under his charge.

Persons Working on Electrical Equipment

2. No person shall be allowed to work on or with electrical equipment of any kind unless he has been previously instructed by an authorized person in the performance of his duties.

Construction and Rating of Apparatus and Relation of Capacity to Duty

3. All electrical equipment shall be rated in accordance with the current-standardization rules of the American Institute of Electrical Engineers.

4. The rating of each piece of electrical equipment shall be stamped on it, or inscribed on a metal plate suitably mounted and maintained upon the equipment. The inscription on the plate shall indicate whether the rating is for continuous or intermittent service, and shall be in accordance with the name-plate requirements of the American Institute of Electrical Engineers.

5. All equipment shall be operated within its rated capacity as defined by the standardization rules of the American Institute of Electrical Engineers.

Permissible Voltages

6. High voltages may be used for transmission purposes underground, provided that such circuits are carried within

metallic sheaths or coverings, with the sheath or covering permanently grounded. This voltage may be applied only to transformers or to motors in which the high-voltage windings are a part of the stationary element. Medium or low voltage may be applied to all electrical equipment.

Mechanical Construction of Installation

7. Care shall be taken to ensure good mechanical construction and neat workmanship in connection with all wiring and the installation of equipment.

Prevention of Accidental Contact

8. Space shall be provided for free movement where regular passing is required or permitted around all unprotected parts of the electric system, and places where persons must pass close to or adjust permanently installed electrical machinery shall be sufficiently lighted.

9. The standing room around all electrical equipment shall be kept as dry as practicable. At any place where it is necessary to manipulate or adjust medium or high-voltage live equipment—including switches, motor starters, and other controlling appliances, excepting locomotives and machines that are moved so frequently that they are provided with trailing cables—there shall be provided and available an insulated platform or mat, which may be of a form and character most in keeping with the circumstances of its use, and which shall be not less effective than a dry board 3 feet by 15 inches by 7/8 inch.

10. All metallic frames, casings and coverings, except those of mining machines and drills, that may become alive, shall be permanently grounded.* All metallic pipe-lines, 1000 feet or over in the interior of the mine, and all pipe-lines leading outside shall be bonded to the return at ends and at intervals not exceeding 500 feet. All metallic pipes in shafts shall be bonded to the return at top and bottom of shafts.

11. Where danger exists of accidental contact with wires carrying electric current, the wiring shall be protected. In haulage roads used as traveling ways the wires need not be

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*It is assumed that the ordinary conditions of operation of locomotives fulfill the requirement of this rule.

protected, if a traveling way of approved dimensions is provided on the side of the entry opposite from the wires. Where wires are run in an entry, in which no one but authorized persons are allowed to travel, or where no hazard from contact exists, the wires need not be protected.

12. Weather-proof varnished cloth, rubber, or similar insulation, unless inclosed in a metallic sheath, when used underground will not be considered as a protection against shock.

13. In unfrequented places where the roof is likely to fall, all electrical conductors shall be especially protected from injury by falling roof.

Carrying Capacity of Conductors

14. The carrying capacity of insulated conductors of distributing circuits shall be determined by reference to the table of carrying capacities laid down in the National Electric Code.

The carrying capacity of bare conductors shall be determined by reference to Table 1, following:

CURRENT-CARRYING CAPACITY OF BARE COPPER CONDUCTORS USED IN MINES

Size of conductor B. & S. gauge	Current capacity Amperes	Size of conductor Circular mils	Current capacity Amperes	Size of conductor Circular mils	Current capacity Amperes
10	80	250,000	690	750,000	1,520
8	105	300,000	790	800,000	1,590
6	145	350,000	880	850,000	1,660
4	210	400,000	965	900,000	1,730
2	280	450,000	1,050	950,000	1,800
1	320	500,000	1,140	1,000,000	1,870
0	375	550,000	1,215	....	.....
00	435	600,000	1,285	....	.....
000	525	650,000	1,370	....	.....
0000	615	700,000	1,450	....	.....

Use of Permissible Equipment

15. The decision as to where and when permissible equipment is required will be made from time to time as necessary by the properly constituted State authority. The term equipment as here used includes everything in the electric circuit.

See also rules 14, 112, 124, 132, 136, 138, 140, 141, 144 and 164.

Inspection and Maintenance

16. At each mine where electricity is used underground, a systematic inspection of all wiring and equipment shall be made at regular intervals, at least once every month. A report of each inspection shall be made by the mine electrician or inspector, and a copy of this report shall be furnished to the man legally in charge of the operation of the mine and kept on file at the mine. The report shall definitely state the condition of each underground station, of the conductors and controlling appliances of each main and branch, power and lighting circuit, and of the motors and controlling appliances of each locomotive, mining machine, pump, hoist, or other piece of electrical apparatus connected to the electrical system of the mine.

Notices and Warnings

17. Caution notices shall be posted at points where such warnings will be most effective in reducing the likelihood of contact, and prohibitory notices shall be posted wherever electrical apparatus that should not be manipulated by unauthorized persons is installed.

Instruction for Resuscitation

18. There shall be posted prominently in every surface and underground station and at the entrance to the mine, instructions for the restoration of persons suffering from electric shock.

All employees who work with or on electrical apparatus must know how to carry out these instructions without delay.

Plan of Electrical System

19. A plan shall be kept at the mine showing the position of all permanently installed electrical machinery and apparatus in connection with the mine electrical system, including cables, conductors, lights, motors, switches, trolley lines and transformers. The plan shall be of sufficient size to show clearly the location of such apparatus, and the scale shall be not less than 200 feet per inch. There shall be stated on the plan the capacity in horse-power or kilowatts of each motor and transformer, and the nature of its duty. Such plan shall

be corrected as often as may be necessary to keep it up to date, at intervals not exceeding six months.

Fire Protection

20. Buckets filled with clean, dry sand shall be kept in all underground stations for immediate use in extinguishing fires. The minimum amount of sand thus stored in any one station shall not be less than 2 cubic feet. No sand will be required if two or more approved fire extinguishers are kept in each station.

DIVISION 2.—SURFACE AND UNDERGROUND STATIONS, GENERATING STATIONS AND SURFACE SUB-STATIONS

General Rules of Safety

See Rules 8 to 11, inclusive.

Generators

21. Generators shall be installed upon adequate foundations in a dry place, free from explosive vapors or flammable material.

22. Machines generating a voltage shall have their outgoing leads and connections entirely within the generator frame or bed-plate, or protected by an approved guard.

Switchboards and Controlling Appliances

See Rules 36 to 42, inclusive.

ELECTRICALLY-DRIVEN VENTILATING FAN: HOUSING, POWER SUPPLY, AND ATTENDANT

Fireproof Buildings

23. All electrically-driven mine-ventilating fans, together with the housing of the motor, shall be built of fireproof materials. Underground electric fans shall not be used where the air current contains gas or coal dust in explosive mixtures, and when used the surroundings shall be fireproofed within a radius of 15 feet from the motor, unless this has a permissible casing.

Power Supply

24. If the line supplying the power is exposed to the influence of lightning, lightning arresters shall be placed near the point where the wires enter the fan-house.

25. The fan attendant shall report immediately any stoppage of the fan to the man legally in charge of the operation of the mine, and means for direct communication between the fan-house and generating station or sub-station supplying the power shall be provided.

Attendant

26. The responsibility for the operation of electrically-driven mine-ventilating fans shall devolve upon an authorized person.

ELECTRICAL EQUIPMENT ON TIPPLES AND OTHER SURFACE STRUCTURES

27. All electrical equipment on tipples and other surface structures shall be installed in accordance with the rules of the National Board of Fire Underwriters.

28. Starters of motors on tipples shall be provided with a no-voltage release, and if practicable, shall be located within sight of the motors that they control or the machines that they operate. A switch or other means for disconnecting the motor from the power supply shall be installed near the machinery.

UNDERGROUND STATIONS

General Rules of Safety

See also Rules 8 to 11, inclusive; also Rule 20.

29. All underground stations shall be fireproof and well ventilated with fresh air, and shall be wired in accordance with the requirements of the National Board of Fire Underwriters.

30. Ventilation may be accomplished through openings in the walls, but with the exception of underground stations in which only switches are installed, the openings shall be provided with non-combustible doors which will either close automatically in case of fire, or can be closed easily from outside the room by the attendant.

Transformer-Stations

See also "Underground Transformers" and Rules 30, 36 to 42, inclusive; 84 and 85.

31. Transformer-stations shall be so arranged that if a transformer explodes the oil will not flow outside the room.

32. Wires shall be carried on non-combustible supporting framework, and the use of wood shall be entirely eliminated. The supporting framework shall be grounded.

33. All transformers in excess of 50-kilowatt capacity shall be equipped with suitable ammeters in either the primary or secondary circuits, or have provision for connecting portable instruments into such circuits.

Pump-Stations

See also Rules 50 to 72, inclusive.

34. Pump-motors operating at voltages exceeding the limits of low voltage shall be wired inside the pump-station, with approved wires carried in conduit sealed to exclude moisture, or sheathed with lead and so placed or protected as to avoid mechanical injury. The metallic covering shall be permanently grounded.

Battery Charging-Station

See also Rules 29 and 30.

35. For ventilating battery charging-stations, means shall be provided for obtaining the air from the intake ways and discharging same to the returning air-way.

Hoist Stations

See "General Rules of Safety for Underground Stations," Rule 34, and Rules 50 to 72.

DIVISION 3.—MACHINES AND APPARATUS

General Rules of Safety

See Rules 3 to 6.

Switchboards

See also Rules 60 to 72 and 75 to 85.

36. Switchboards shall consist of a substantial framework of iron pipe, or structural steel, on which shall be mounted a panel or panels of non-combustible, non-absorbent, insulating material which is mechanically strong, and has insulating qualities suitable for the voltage at which it is

used. All switchboard mountings, instrument transformers and motor casings shall be grounded.

37. The panels of insulating material may be omitted if each piece of equipment carried on the switchboard is provided with an individual base of insulating material of the character specified for the panels and of adequate dimensions, or has its current-carrying parts mounted on approved insulation self-contained in the equipment, which shall be especially designed for mounting on iron pipe or structural-steel framework.

38. Switchboards shall be so placed that there should be a straight passageway of not less than 3 ft. in front and in back of the switchboard. These 3-ft. passageways shall be clear of all apparatus mounted on the board and shall be kept free of all obstructions. The space back of the switchboards shall be provided with 3-ft. exits at both ends, but shall not be entered by an unauthorized person, and shall not be used for the storage of material or clothing.

39. The space behind switchboards where the voltage exceeds low voltage shall be kept closed by locked doors, which can be opened from within without the use of a key, but from without with the key only.

40. Where the voltage of the power supply exceeds the limits of medium voltage, the live high-voltage metal-work on the front of the switchboard within 7 ft. of the floor shall be protected. In case of existing installations that do not meet the requirements with this respect to passage space in back of the switchboard, no person shall be permitted back of the board while any apparatus or circuits connected therewith are alive.

41. Conductors shall not cross the passageways back of switchboards except below the floor or at a height of 6½ ft. above the floor.

42. There shall be provided for each generator an indicating ammeter or wattmeter of suitable capacity, and for all generators a voltmeter, that, by closing a switch or manipulating a plug connection, can be connected to any generator.

ELECTRIC VENTILATING FAN EQUIPMENT

Housing and Power Supply

See Rules 23 to 25.

Capacity of Motors

43. Motors that operate ventilating fans shall be of sufficient capacity to drive the fan at the maximum speed of the motor under normal conditions of service without overloading.

Control of Motors

44. Non-automatic motor-controlling appliances, which are used with motors that are not self-starting, shall be so arranged that the motor will be disconnected automatically from the supply circuit in case the power supply fails.

ELECTRIC HOISTING EQUIPMENT

Shaft Hoists

45. All electrically-operated shaft hoists shall be provided with a device approved for the prevention of overwinding. Where the hoist is used for handling men, additional provision shall be made to prevent overwinding at the man landing. Where a separate overwind protection for men is used a visual signal shall be provided to indicate at all man landings that the overwind device is set for hoisting men. It shall not be possible to operate the signal lights without setting the man landing overwind.

46. Shaft hoists shall have a brake which will keep the hoisting drum under the control of the operator. The brake shall be provided with an automatic trip or release, which will apply the brake in case the power supply fails, in case of overwinding or overspeeding, and this brake shall have sufficient capacity to hold the maximum unbalanced load.

47. Hoists for handling men shall be so arranged that, when hoisting and lowering men and the legal rate of speed is exceeded, the hoist will automatically be brought to a stop. If hoists are designed to operate in balance, the driving motor shall be of sufficient size to hoist full loads of men in a maximum unbalanced condition in case of emergency.

48. All electric safety devices shall be tested at the begin-

ning of each shift and a record of such tests shall be made and signed by an authorized person and kept on file at the mine.

Slope Hoists

49. All electrically-operated slope, tail-rope, or endless-rope hoists in mines shall be fitted with adequate controlling devices of approved design.

UNDERGROUND MOTORS OTHER THAN LOCOMOTIVES

See Rules 3 to 7 and "General Rules for Safety for Underground Stations," and Rule 34.

General Construction

50. Motors for use in damp places shall have approved moisture-resisting insulation.

51. The outgoing leads and connections of all motors shall be protected from accidental contact by insulation or grounded coverings. Motors that operate at voltages exceeding low voltage shall have their outgoing leads and connections entirely within the motor-frame or bed-plates, or protected by an approved guard.

Permissible Motors

52. See Permissible Equipment, paragraph 15.

Portable Motors

53. The motors and controlling appliances of portable pumps, hoists, and similar portable apparatus shall be securely mounted and with frame grounded to a common base with the machine that is to be operated. All wiring between the motor and the controlling appliances shall be done in accordance with paragraph 7.

54. Mining-machine motors, and other motors that use a trailing cable, shall be provided where the cable enters the frame of the machine with an approved means for preventing abrasion of the insulating covering of the cable. An approved insulating clamp placed within the frame, or protected by an approved metallic covering, shall be provided for taking all mechanical strains upon the cable terminals. (See also Rule 55.)

Trailing Cables

55. Trailing cables for portable machines shall be especially flexible, heavily insulated, and protected with extra stout braiding, hose pipes, or other effective coverings. (See also Rule 74.)

56. Each trailing cable in use shall be examined daily by the machine operator for abrasion and other defects; and he shall also be required to observe carefully the trailing cable while in use, and shall at once repair any defect or report it to the person in charge of electrical equipment.

57. In the event of the trailing cable in service breaking down or becoming damaged in any way, or any person receiving a shock from it, it shall be at once put out of service. The faulty cable shall not again be used until it has been repaired and tested by an authorized person.

58. The trailing cable shall be divided at the motor, but only for such length as is necessary for making connection to the motor; and the cable, with its outer covering complete, shall be clamped securely to the motor-frame in such a manner as to protect the cable from injury, and to prevent any mechanical strain being borne by the signal ends that make electric connection to the motor.

Permissible Portable Motors

59. See Permissible Equipment, paragraph 15.

Control

60. Every stationary motor and every portable motor used underground, except mining machines and drills, shall be protected, together with its starting device.

Direct-Current Motors

61. On two-wire ungrounded circuits, each wire shall be protected by an automatic circuit-breaker, or by a fuse and switch. On two-wire grounded circuits, the ungrounded wire shall be protected by a switch, and either a fuse or an automatic circuit-breaker. When the circuit-breaker trips free from the closing handle, the switch may be omitted. On three-wire circuits each outside wire shall be protected by a fuse or automatic circuit-breaker, but no fuse or automatic circuit-

breaker shall be used in the neutral wire. A triple-pole switch, to isolate the fuses or circuit-breakers from live source, shall be used. In case circuit-breakers are used, they shall be so arranged that the opening of the circuit-breaker in one wire will cause the other circuit-breakers to trip.

Alternating-Current Motors

62. On three-phase delta or Y (star) connected circuits, each wire shall be provided with a fuse or automatic circuit-breaker. When circuit-breakers are used, two overload trip-coils shall be used for underground neutral systems, and three overload trip-coils for grounded neutral systems. In either case the automatic circuit-breakers shall be so arranged that the opening of one will open the others. Switches for isolating the fuses or circuit-breakers from live source shall be provided. When air-brake circuit-breakers, which trip free from the handle are used, the switch may be omitted.

63. The above devices shall be installed in a convenient position in sight of the motor or in sight of the equipment that the motor operates. The controlling appliances of stationary motors, except the controllers of hoist and similar equipment, shall be mounted upon a switchboard. Resistances may be mounted upon a separate metallic framework.

64. Underground motors that operate care or coal-handling equipment shall be provided at a point near such equipment with a switch, or other means for disconnecting the motor from the power supply.

65. Underground motors used to drive booster or auxiliary fans shall be so designed or equipped that they will start automatically, when their circuits are connected to the power supply.

66. All non-automatic, current-limiting starting devices, except those used with mining machines, drills, locomotives, and hoists, shall be provided with a no-voltage release.

67. Electrically-operated mining machines and drills may be protected by a single fuse, and need not be equipped with a line-switch if an approved current-rupturing device is installed at that end of the trailing cable which is nearest to the power supply. If a hook is used for this purpose it shall

be provided with an insulated handle of approved construction. If cable reels are used, they shall be provided with an approved means for opening the circuit under full motor load. (See Rule 15.)

68. All insulating material used in connection with starting resistances shall be non-combustible. This includes the insulation of wire used for the internal wiring of resistances.

69. All switches shall be so installed that they can not close by gravity.

70. Every underground stationary motor of 100 brake horse-power or over shall be provided with a suitable meter to indicate the amount of load on the machine.

71. All wiring between motors and their controlling appliances shall be insulated.

72. Overload release devices on starting rheostats and compensators will not be considered as taking the place of circuit-breakers, if such devices are inoperative during the starting of the motor. If automatic starting devices are used they shall be inclosed in a fireproof inclosure, or mounted upon a metallic framework clear of all combustible material.

LOCOMOTIVES

73. Gathering locomotives may be operated with a single-conductor trailing cable if the track provides a good metallic return; otherwise double-conductor trailing cable must be used.

74. The trailing cable of gathering locomotives shall be provided with an approved insulated hook or other device for making connection to the trolley wire; and if a double-conductor cable is used a similar hook or device shall be provided for making connection to the track rail.

UNDERGROUND TRANSFORMERS

See "Underground Stations." "Transformer Stations" and Rules 84 and 85.

DIVISION 4.—CIRCUITS AND CONDUCTORS PROTECTION AND CONTROL

Protection of all Circuits

75. All circuits leading from generating stations and sub-stations, except transformer sub-stations, shall be provided at their source with current-interrupting devices of such capacities, and so installed and adjusted that the circuit will be opened if the current in the circuit exceeds the carrying capacity of the conductors leaving the station. All circuits leading underground exceeding 50 kilowatts capacity shall be provided with a suitable ammeter or means for inserting a portable ammeter.

76. Two-wire ungrounded direct-current circuits shall be protected by an automatic circuit-breaker or by a fuse and switch in each wire. Two-wire grounded direct-current circuits shall be protected by a switch, and either an automatic circuit-breaker or a fuse in the ungrounded wire. When the circuit-breaker trips free from the closing handle the switch may be omitted. Three-wire ungrounded direct-current circuits shall be protected by a fuse or automatic circuit-breaker in each outside conductor, but no fuse or circuit-breaker in the neutral conductor, and in addition a triple-pole switch to isolate the fuse or circuit-breaker from live sources. Where one of the outside wires is grounded, this should be treated as neutral and protection provided only in the other two wires.

77. Three-phase delta or Y (star) connected alternating-current circuits shall be protected by a fuse or an automatic circuit-breaker in each wire. When automatic circuit-breakers are used, two overload trip-coils shall be provided for ungrounded neutral systems, and three overload trip-coils for grounded neutral systems. In either case the automatic circuit-breakers shall be so arranged that the opening of one will open the others. Switches for isolating the fuses or circuit-breakers from live sources shall be provided.

Protection of Circuits Leading Underground

78. Each outgoing circuit that leads underground, and extends over the surface of the ground 500 ft. or more from the generating station or sub-station, shall be equipped with lightning arresters of approved type, with proper ground con-

nection at the generating station or sub-station, and also at the point where the circuit enters the mine.

79. Lightning arresters shall be connected on the secondary side of all transformers that feed underground circuits, unless there is provided other suitable means for discharging abnormal voltages. Lightning arresters on the primary side will be considered suitable if the secondary circuit above ground is less than 50 ft. long.

80. Each power circuit leading underground shall be provided with a disconnecting switch in each conductor capable of opening the circuit under load. This switch shall be placed where the circuit enters the mine or within 100 ft. of this point.

81. Each individual circuit leading underground, whether alternating or direct current, shall be provided with automatic overload protection at or before the point where it enters the mine working. If two circuit-breakers are used, they must be so interlocked that both will open in the event of one opening.

Protection of Underground Circuits

82. All branch circuits of a network shall be provided with current-rupturing devices of such capacity, and so installed, that the current in any part of the branch circuit cannot exceed the carrying capacity of that part as defined by Rule 14, if the length of the complete branch circuit exceeds two miles.

83. Minimum size of conductors used to supply power to coal-cutting equipment shall be No. 4 B. & S. Minimum size of conductors for supplying pumps shall be No. 8 B. & S. All conductors supplying pumps and motors shall come within the limits given under paragraph 14.

Protection of Underground Transformer Circuits

84. All transformers shall be equipped with automatic current-interrupting devices in at least the primary side of the transformer; and also in the secondary side of the transformer, if the current-interrupting devices in the primary are not readily accessible from the transformer.

85. When the voltage of circuits entering or leaving underground transformers exceeds the limits of medium voltage, current-interrupting devices shall consist of an oil circuit-breaker in each conductor, and each switch shall be provided with an automatic overload-trip.

86. When the voltage of circuits entering or leaving transformers does not exceed the limits of medium voltage, their protective devices may consist of an oil circuit-breaker as described above, or of a knife-switch and automatic circuit-breaker in each conductor, except that approved fuses may be substituted for circuit-breakers.

INSTALLING OF SURFACE CIRCUITS

Surface Transmission-Lines

87. Power wires shall not be placed on the same cross-arms with telegraph, telephone, or signal wires. When placed on the same pole with such wires and below them, the distance between the two inside pins of each cross-arm carrying power wires shall not be less than 26 inches.

88. Transmission-lines operating at voltages in excess of 5000 volts shall not be placed on the same poles with telephone circuits which are or can be connected underground, unless the telephone lines are provided with approved protective devices capable of preventing the higher voltage from entering the underground telephone circuits.

Surface Trolley-Lines

89. All surface trolley-lines shall be kept at least 6½ ft. above the top of the rail, and shall be protected at all regularly provided crossings by a guard, which will prevent men from coming in contact with the wire either directly or by bringing tools in contact with the wire.

90. That part of the trolley circuit used for surface operations shall be so arranged that it can be entirely disconnected from the power supply without cutting off the current inside of the mine, or interfering with the operation of other apparatus not a part of the trolley system.

91. Trolley-wires shall not be smaller than No. 8 B. & S. gauge copper wire or No. 4 B. & S. gauge silicon-bronze wire,

and shall withstand easily the strain put upon them when in use.

92. Trolley wires shall have double insulation from the ground unless an approved single insulator is used. In wooden-pole construction the pole will be considered as one insulation.

METHODS OF CARRYING CIRCUITS UNDERGROUND

Suspension in Shafts

93. All power conductors installed in shafts shall be covered with approved insulating material throughout or protected in an approved manner, and shall be firmly fastened to or suspended from properly supported insulators, unless the conductors are sheathed with lead or inclosed in conduit. Conductors used as returns in shafts for ground-return systems shall be supported on insulators, but need not be covered with insulation.

94. Shaft cables which are so constructed that the whole or any part of the cable is not self-sustaining, shall be supported in an approved manner at such intervals as may be necessary to prevent the occurrence of undue strains in sheath, insulation, or conductors.

95. Shaft cables shall be so placed or protected that they are not liable to injury from falling material.

Suspension in Bore-Holes

96. All power conductors, except grounded returns installed in bore-holes, shall be covered with insulation and supported in an approved manner, which shall prevent the occurrence of undue strains in sheath, insulation or conductors.

97. Telephone or signal wires shall not be installed in the same bore-hole with power wires, unless either the signal or the power conductors in the bore-hole are encased in metallic coverings that are permanently grounded.

Entrance of Conductors Through Drifts or Slopes

98. Low and medium-voltage power conductors in drifts or slopes may be installed bare, but shall be carried on suitable insulators securely fastened to the sides or roof of the

entry. If the drift or slope is used for traveling, the conductors shall be protected as required in Rule 105.

INSTALLATION OF UNDERGROUND POWER CIRCUITS AND CONDUCTORS

99. All joints in wires shall be made electrically and mechanically efficient either by the use of an approved mechanical connector or by soldering.

100. Underground conductors will not be considered as shock-proof unless they are encased in metallic covering that is thoroughly grounded.

101. Low and medium-voltage conductors shall be carried at least 6 in. from the trolley-line and on the nearest rib side of it, and shall be supported on insulators of an approved type. When the height of the entry does not exceed 5 ft., the insulators shall be placed not more than 20 ft. apart and as much closer as is necessary to support the wires properly.

102. If the height of the entry is more than 5 ft., the insulators shall be placed not more than 30 ft. apart, and as much closer as may be necessary to support the line properly.

103. High-voltage conductors shall be carried in metallic coverings, and shall be installed in an approved manner with special reference to the conditions under which they are installed.

104. The negative or return wire of grounded systems shall be treated in exactly the same menner as the positive or live wire, and afforded the same support and insulation.

105. All conductors in traveling ways, except haulage-roads used for traveling (see Rule 11) and medium-voltage conductors in room entries, shall be protected throughout that part of the entry that is used for traveling, unless the conductors are at least 6½ ft. above the rail, in which case protection will be necessary only at those points where men are required to work beneath the conductors or pass under them. The insulators may be supported directly from the roof or side or may be attached to timbers not less than 3 by 4-inch size, or may be secured to steel mine timbers. The insulators shall be placed so that the height of the conductors above the bottom will be comparatively uniform.

106. All conductors shall be strung with the least practicable sag between the supporting insulators, and shall be maintained in this condition and kept from contact with rock, coal, timber, or other non-insulating material.

107. All main conductors shall be sectionalized by approved switches at points not more than 2500 ft. apart.

Branch Conductors

108. Branch conductors shall be supported and maintained in the same manner as main conductors, and given the same protection.

109. At the point where branch circuits leave the main circuits there shall be placed a switch for cutting off all current from the branch circuits.

110. Where wires pass through partitions or wooden or other brattices, they shall be protected with approved insulating tubes held in place with tape or thoroughly cemented in place so that they can not move.

111. Entries or passageways in which wires are installed must be kept sufficiently free from rock, slate, or other material to permit ready access to the wires at all times.

Room Wiring*

112. Rooms in which gas or coal dust exist in explosive mixtures shall not be wired. Where room wiring is permissible it shall be treated as branch circuits, and equipped at the room entrance with switches or some other device that will entirely disconnect the wiring when not in use.

Trolley-Wires

113. Trolley-wires shall be of hard-drawn copper not smaller in size than 1/0 B. & S. gauge, and shall be securely supported on approved hangers, which may be attached directly to the roof or securely fastened to timber or equivalent.

114. The height of trolley-wires above the top of the rail shall be made as uniform as practicable.

115. Trolley-wires shall be so placed as to give the maximum clearance practicable, and kept in as straight a line as possible.

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*The U. S. Bureau of Mines recommends that rooms be not wired.

116. On straight runs, the hangers shall be placed not more than 20 ft. apart where the height of the roof above the track is 5 ft. or less, and not more than 30 ft. apart where the roof is more than 5 ft. above the track. On curves, the hangers shall be placed so close together that the trolley-wire at any one hanger may be entirely disconnected without exposing the locomotive runner to danger of contact.

117. Underground trolley-lines shall be sectionalized every 2500 ft. by placing in the line a switch by which the line can be entirely disconnected from the power supply. All branch trolley-lines shall be provided with a frog at the point where they leave the main, and also with a switch installed at or near the frog, by which the branch can be disconnected from the main.

118. Trolley-wires that are less than 6½ ft. above the top of the rail shall be protected at all points where men are regularly required to work or pass under them, and at all points where men may come in contact with the wires.

Bonding

119. The tracks of all main haulage systems that use a rail return shall be bonded at every rail joint, and cross bonding shall be placed at intervals not exceeding 200 ft. Special provision shall be made for bonding around all switches, frogs, or openings in the track so as to insure a continuous return.

Lighting Circuits in Places Where Gas or Coal Dust Do Not Occur in Dangerous Mixtures

See also Rules 133 to 135; 137 to 139.

120. Lighting wires shall be attached to power wires by soldering or by fastening under a set-screw in a lug attached to the trolley-hanger, or by such other devices as will prevent the wires from becoming loose.

121. All wiring shall be supported on non-combustible, non-absorbent insulators, which shall separate the wires by at least 1 in. from the surfaces wired over. Wires of opposite polarity shall be kept at least 2½ in. apart for low voltage, and 5 in. apart for medium voltage.

122. No wires smaller than No. 14 B. & S. gauge shall be used for lighting circuits in non-gaseous places.

123. When the ground is used as a return for lighting circuits, the return wire shall be attached to the track by bonding to the rail or by attachment to regular bonding in an approved manner. This ground connection shall be made of not less than No. 8 B. & S. gauge copper wire, which shall be buried below the surface and carried to the side of the entry, and thence on porcelain insulators to the roof or a point at least 5 ft. above the track.

Lighting Circuits in Places Where Gas or Coal Dust Occurs in Dangerous Mixtures*

See also Rules 136 and 140.

124. The potential of lighting circuits shall not exceed the limits of low voltage.

125. Only permissible equipment shall be used for lighting circuits.

126. The circuits shall be run from the outside, with all switches and protective devices on the surface, or by using permissible switches, fuses, or circuit-breakers situated underground, or by ventilating with fresh air the place where the switches and fuses are installed.

127. If the circuits are run from the outside with the controlling devices installed on the surface, the conductors leading underground shall be not smaller than No. 8 B. & S. gauge, and each circuit shall be provided above ground with a suitable ammeter.

128. Each circuit shall have a double-pole switch and fuses or circuit-breakers in the case of two-wire systems, and a three-pole switch and fuses or circuit-breakers in the case of three-wire systems.

129. The fuses or circuit-breakers shall be designed or arranged to operate when the allowable load is exceeded by 25%.

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*Bureau of Mines recommends that in mines in which fire-damp is given off in dangerous quantities, the use of lighting circuits be confined to those entries and places that are ventilated by intake air-currents which have not passed by or through abandoned or active workings, except that a lighting circuit may be used in a shaft or slope bottom ventilated by a return air-current in which the percentage of methane does not exceed 1%.

130. No wire smaller than No. 12 B. & S. gauge shall be used in lighting circuits except for the leads of weather-proof sockets, and these shall not be less than No. 14 B. & S. gauge.

131. In case distribution is made from a point underground, the distribution switches and fuses shall be mounted on a non-combustible panel, placed in a metal cabinet and fitted with a hinged door. This cabinet shall be used whether permissible switches are required or not. The cabinet shall be fitted with a door properly hinged, so that it will close tightly and shall be provided with a fastening which will hold the door securely in a closed position.

132. Flexible lamp-cord connections are prohibited except for portable lamps, as covered by Rule 141.

DIVISION 5.—MISCELLANEOUS EQUIPMENT

FIXED ELECTRIC LAMPS

For wiring and control requirements of fixed electric lamps, see Rules 120 to 132, inclusive.

133. Electric lamps used to illuminate haulage-roads, side tracks, and similar passageways where gas or coal dust do not exist in explosive mixtures, may be connected to power and trolley-lines.

134. Lamps may be connected in multiple or in series, and no fuse or switch will be required for one lamp or series of lamps. A switch may be used if it is desired to switch the lamps on or off, and a fuse must be used if it is necessary to protect any considerable length of wire.

135. All sockets shall be of the keyless weather-proof type, and have no exposed metallic parts. Lead wires shall be rubber-covered, and of a size not smaller than No. 14 B. & S. gauge. The lead wires shall be made a part of the socket and permanently connected thereto. These wires shall be attached directly to the line wires by soldering or by mechanical connectors. Sockets shall not be supported by the lines wires, but by an additional insulator or insulators, or some other device that will be entirely independent of the line wires.

136. In mines that contain gas or coal dust in explosive mixtures, and in which electricity is used only for lighting

or where the lighting circuits are separate from the power circuits, the voltage of such circuits shall not exceed the limits of low voltage, and all lamps shall be connected in multiple.

137. Not more than 24 lamps shall be attached to any one circuit, and the power taken by any one circuit shall not exceed 1300 watts.

138. Permissible mine incandescent lamps shall be used where gas or coal dust occurs in explosive mixtures.

139. Incandescent lamps shall be so installed that they cannot come in contact with combustible material.

140. Electric lamps shall be replaced by an authorized person only, and in places where gas or coal dust exist in explosive mixtures, only after an examination for gas has been made with a safety-lamp.

Portable Electric Lamps

141. Portable incandescent lamps, other than permissible battery-lamps, shall be protected by a heavy wire cage, which completely encloses both lamp and socket, and shall be provided with a handle to which both cage and socket are firmly attached, and through which the cord supplying the current is carried. The socket shall be keyless, and the lamp circuit shall be protected by a fuse.

142. When a portable lamp is one of several connected in series between a source of voltage and the earth, the portable lamp shall be the one in the series electrically nearest to the earth connection.

143. The use of portable lamps with leads of ordinary flexible cord is prohibited. Only lamp cords approved for this purpose shall be used.

Self-Contained Portable Electric Lamps*

144. Permissible self-contained portable electric lamps shall be used in places where gas or coal dust occurs in explosive mixtures.

*The use of self-contained portable electric lamps of suitable design and construction is recommended for all coal mines, provided that in places where gas or coal dust occur in dangerous mixtures, or in places where blackdamp is given off in large quantities, frequent inspections with safety-lamps are made.

Electric Shot-Firing Equipment

145. Electricity from any grounded circuit shall not be used for firing shots.†

146. Special precautions shall be taken to prevent shot-firing conductors from becoming grounded, or from getting in contact with other electric circuits.

147. Only authorized persons shall be allowed to fire shots with electricity in a mine.

148. The electric detonators or igniters and leads thereto shall be suitable for the conditions under which the blasting is carried on and shall be approved by the United States Bureau of Mines.

149. Portable shot-firing machines shall be of efficient design and shall be substantially constructed. All such machines shall be enclosed in strong, tight casings.

150. Primary or secondary batteries used for shot-firing shall be enclosed in a well-constructed casing provided with a special form of contact-plug for making the connection between the batteries and shot-firing leads. The design of the plug shall be such that considerable pressure will be required to make the contact, which will be immediately broken unless the plug is forcibly held in position.

151. There shall be no exposed contacts on the outside of the battery casings.

152. All portable shot-firing machines shall be equipped with a detachable handle, connecting plug, key, or similar approved device without which the shot-firing circuit cannot be closed, and which shall under no circumstances pass from the custody of the person authorized to fire the shots.

153. No shot-firing device shall be connected to the shot-firing leads until all other steps preparatory to the firing of the shot have been completed, and all persons have moved to a position of safety.

Disconnection of Leads

154. Immediately after the firing of a shot, the firing leads

†It is recommended that all shots be fired electrically, and for inside firing, shots be fired separately—and one at a time, on account of the danger of causing blown-out shots and resultant explosions. If fired in groups the firing should be done only from the surface.

shall be disconnected from the supply of electricity, and no person shall aproach a shot which electricity has failed to explode until the firing leads have been so disconnected, and an interval of 10 minutes has elapsed since the last attempt to fire the shot.

Shot-Firing From Surface

155. In coal mines employing the system of firing shots electrically from above ground when everyone is out of the mine, a complete metallic circuit shall be employed, and both wires shall be covered with insulation and supported upon glass or porcelain insulators.

156. There shall be a switch at the mouth of each working place, so that the circuit can be kept open while miners are at work, and closed only when the shots have been prepared, and the miner or miners are leaving the place.

157. There shall be a locked switch in the circuit at the entrance to each heading or side entry, which shall be locked open and be thrown-in only by an authorized person, when all the men are out of the respective heading or branch entry.

158. There shall be in the circuit at the foot of the shaft or slope, two plugs with flexible leads not less than 5 ft. long, to break further the main circuit of the shot-firing system until all the men in the mine have gone out, when the plugs will be put in by the one man authorized to do so. Provision shall be made for locking the plugs out of circuit.

159. There shall be placed in the power-house a locked switch to be used for connecting the shot-firing circuit to the generator or power-line. This switch shall be thrown-in only by the man who is authorized to do the shot-firing, and not until the men have been checked out of the mine.

160. There shall be placed in the shot-firer's cabin a locked firing-switch, which shall be thrown only by the authorized shot-firer after all the men are out of the mine, and after all other switches have been thrown-in. In firing shots, this switch shall be thrown but once.

161. To insure that all men are out of the mine, an approved system of checking shall be employed.

162. All shot-firing lines shall be carefully insulated and the two wires that form the circuit shall be placed on the side of the entry or passageway opposite from that on which the trolley-wire is placed, and so far as possible other roads than the trolley road shall be used for carrying the wires into the working places.

Electric Signaling Equipment

163. The parts of electric signaling systems used in connection with mines shall be designed, constructed, and installed in an approved manner. No voltage in excess of 25 volts shall be applied to signal circuits in places where gas or coal dust occur in explosive mixtures.

164. Only permissible equipment shall be used in places where gas or coal dust occurs in explosive mixtures.

165. Suitable precautions shall be taken to prevent electric signal or telephone wires from becoming grounded or from coming in contact with electric conductors, whether insulated or not. Signal circuits and telephone wires shall not be installed on the same side of an entry as power conductors.

BRIEF OF DISCUSSION ON JOINT REPORT OF SUB-COMMITTEES ON STANDARDIZATION OF UNDERGROUND POWER TRANSMISSION AND STANDARDIZATION OF POWER EQUIPMENT

By WARREN R. ROBERTS, Chairman of General Committee

The Chairman of these two Committees decided that the subject matter each of them had under consideration was so interwoven that it was best to consolidate their efforts, and their work was therefore carried on in joint sessions, and they rendered a joint report.

The Committees were most fortunate in having Mr. Kiser, chairman of one of the Sub-Committees, present at the Standardization Conference to present their joint report. He stated that the report was entirely too long, and contained too much technical data, he thought, to make it of interest to the Conference, and therefore discussed the most salient features of the joint report.

Mr. Kiser first expressed, on behalf of the Chairman of both

these Committees their sincere appreciation of the keen interest shown in the work by the members of these Committees. He also placed in the record an expression of the Committees' indebtedness to the U. S. Bureau of Mines for providing not only a meeting place, but a secretary during their joint meetings. Mr. Kiser explained that the work of their Committees, and therefore their report, was separated into two general divisions: first, the standardization of practice in the installation and operation of equipment, and the standardization of equipment.

As the Electric Power Club has for its object the standardization of capacities, voltages, speeds, and essential mechanical features of electric motors, generators, transformers, etc., and as its standards are the accepted standards throughout the country, it was suggested that the Committee adopt them as their standards for such equipment. It was also suggested that the standardization rules of the A. I. E. E. be adopted as our standards of technical matters. In giving attention to the standardization of practice, the Committee considered that this work was very thoroughly covered by the U. S. Bureau of Mines Technical Paper No. 138, entitled 'Suggested Rules for Installing and Using Electrical Equipment in Bituminous Coal Mines.' The data contained in this Bulletin was therefore taken as the basis for the work of the Committee. Each rule was thoroughly discussed and revised when it seemed advisable to do so for the purpose of clarifying it, or making it conform to present day practice.

Lastly, the Committee advises that the rules as they appear in the report of this Committee are prepared especially to cover coal-mining conditions, but they are applicable to metal mines, by omitting certain paragraphs which concern the existence of gas or coal dust in explosive mixtures.

This brief digest of the verbal presentation of this most valuable report is intended simply to give an insight into the methods of procedure by this Joint Committee, and to indicate the careful and thorough manner in which they have done their work. A study of this joint report, however, is necessary to appreciate the amount of good work performed on behalf of the industry by this Joint Committee.

DIGEST OF PAPER ON SUGGESTIONS FOR THE STANDARDIZATION OF HAMMER DRILLS AND ACCESSORIES

Prepared by GEORGE H. GILMAN, East Boston, Mass. Member of the Sub-Committee on Drilling-Machines and Drilling

Presented at the Meeting of the Sub-Committee on Drilling-Machines

I do not recommend an attempt being made to restrict the quantity of sizes and types of standard machines to a point that will tend to lower the overall efficiency of the drilling operation, regardless of the fact that from the manufacturer's viewpoint the fewer the number and types of machines the greater will be the volume of each type built, with a consequent reduction in manufacturing costs. However, with a variety of types and sizes of machines to choose from, the individual mine operator will be able to select the minimum number to meet to the best advantage the requirements of the work, and after the selection is made, it will then be necessary for the manufacturer's engineer to regulate the mechanism of the drill in order that it may be adapted to the conditions of ground and air pressure to the best advantage. With this in view, I recommend the standardization of the following machines:

Details, Capacity and Use of Machines

(1) A hand-held hammer-drill to weigh 25 to 30 lb., having automatic bit rotation, double-grip handle, drill-steel retainer, automatic lubricator, means for cleaning the drill-hole with air only, and a chuck adapted for 7/8-in. quarter-octagon hollow drill-steel, having 7/8-in. quarter-octagon collared shank 3/4 in. long.
Capacity—holes to a maximum depth of 4 ft. with a bottom diameter of 1 1/4 inches.
Use—scaling walls and hitch cutting from ladder or staging, light pop-holing, etc.

(2) A hand-held hammer-drill to weigh 30 to 40 lb., having automatic bit rotation, double-grip handle, drill-steel retainer, automatic lubrication, water attachment, and chuck adapted for 7/8-in. quarter-octagon hollow drill-

steel having a 7/8-in. quarter-octagon collared shank 3¼ in. long.

Capacity—holes to a maximum depth of 8 in. with a bottom diameter of 1¼ inches.

Use—pop-holing in boulders, blast-holes in shrinkage stopes, quarry work, etc.

(3) A hand-held hammer-drill to weigh 30 to 40 lb., having automatic bit rotation, double-grip handle, drill-steel retainer, automatic lubrication, and chuck adapted for collared solid auger drill-steel of cruciform section 1½-in. diameter (spiral to be 3½ turns per foot), having a 7/8-in. quarter-octagon collared shank 3¼ in. long.
Capacity—holes to a maximum depth of 9 ft., with a bottom diameter of 1¾ inches.
Use—blast-hole drilling in hematite iron ore, hard pan, gravel, and earth formations.

(4) A hand-held hammer-drill to weigh 55 to 60 lb., having automatic bit rotation, double-grip handle, drill-steel retainer, automatic lubrication, water attachment, and chuck adapted for 7/8-in. quarter-octagon hollow drill-steel having a quarter-octagon collared shank 3¼ in. long.
Capacity—holes to maximum depth of 12 ft. with a bottom diameter of 1¼ inches.
Use—blast-hole drilling in shafts, open-pit mining and deep-hole drilling in quarries.

(5) A mounted hammer-drill to weigh 115 to 125 lb., having a shell and feed-screw equipped with a sliding trunnion and adapted for a normal drill-steel change of 24 in. The hammer engine to have automatic drill-bit rotation, drill-steel retainer, automatic lubrication, water attachment, and chuck adapted for 7/8-in. quarter-octagon hollow drill-steel having a quarter-octagon collared shank 3¼ in. long.
Capacity—holes to be a maximum depth of 12 ft. with a bottom diameter of 1¼ inches.
Use—breast stoping, light drifting, and tripod drilling.

(6) A mounted hammer-drill to weigh 160 to 180 lb., having a shell and feed-screw adapted for a normal

steel change of 24 in. The hammer engine to have automatic drill-bit rotation, automatic lubrication, water attachment, and chuck with bayonet lock adapted for 1¼-in. round, lugged hollow drill-steel having a round shank 3 13-16 in. long.

Capacity—holes to a maximum depth of 20 ft., with a bottom diameter of 1⅝ inches.

Use—heavy drifting and tripod work.

(7) A pneumatic feed hammer-drill to weigh 80 to 90 lb., having a pneumatic-feed extension to the hammer engine adapted for a normal steel change of 18 in. The hammer engine to have automatic drill-bit rotation, automatic lubrication, water attachment, and chuck adapted for ⅞-in. quarter-octagon hollow drill-steel, equipped with a quarter-octagon collared shank 3¼ in. long.

Capacity—holes to a maximum depth of 12 ft. with a bottom diameter of 1¼ inches.

Use—overhead drilling in stopes and raises.

(8) A pneumatic feed hammer-drill to weigh 60 to 65 lb., having a pneumatic-feed extension to the hammer engine adapted for a normal steel change of 18 in. and adapted to be oscillated by hand. The hammer engine to have automatic lubrication, water attachment, and chuck adapted for ⅞-in quarter-octagon hollow drill-steel, equipped with a quarter-octagon collared shank 3¼ in. long.

Capacity—holes to a maximum depth of 8 ft. with a bottom diameter of 1¼ inches.

Use—overhead drilling in stopes and raises where the conditions of the work do not demand that the drill be equipped for automatic rotation of the drill-steel.

Size of Drill-Steel

In making recommendations for machine standardization the standardization of drill-steel should be embodied, for to my knowledge there is no good reason why for 98% of the underground conditions encountered in metal mining there should be more than three sizes and shapes employed.

(a) 7/8-in. quarter-octagon hollow drill-steel equipped with a 7/8-in. collared quarter-octagon shank 3¼ in. long.

Applicable to machines 1, 2, 4, 5, 7, and 8.

(b) 1½-in. solid cruciform twisted drill-steel equipped with a 7/8-in. collared quarter-octagon shank 3¼ in. long.

Applicable to machine 3.

(c) 1¼-in. round, hollow drill-steel equipped with a 1¼-in. round, lugged shank 3 13-16 in. long.

Applicable to machine 6.

The 7/8-in. hollow quarter-octagon section is recommended under (a) because of its angular shape, which, when rotated in the drill-hole, facilitates the ejection of the sludge and prevents mud collars from forming. In cross-sectional area it exceeds that of the hexagon, round, and cruciform shapes of corresponding diameter, thus providing greater strength in comparison, and when the shanks are made in this section, greater bearing surface to resist wear both in the shank and chuck bushing. The shape of the quarter-octagon steel also facilitates the forging of a four-winged bit as the wings may be drawn from the four flattened corners of the bar, and in addition it provides an ideal gripping surface for the dies of the drill-sharpening machine.

Heretofore it has been an accepted theory that in the case of pneumatic-feed drills, a collarless drill-shank is desirable, for by its use the work of putting the collar on the steel is obviated. This assumed advantage is, however, subject to question when it is considered that the employment of shankless drill-steel necessitates the use of an anvil-block or striking-pin interposed between the hammer-piston and the drill-steel, which depending upon its weight and the character of the blow delivered by the pneumatic hammer, results in a loss of from 20 to 30% of the effectiveness of the blow in transmission through the part. That it precludes the possibility of standardizing on two sizes or types of drill-steel for the average hard-rock metal mine and, furthermore, that it precludes the employment of a drill-steel retained as an integral part of the machine for extracting the drill-steel from the drill-hole. The desirability of a collar or lugs at the base of the shank of drill-

steel that is adapted for drifting, sinking, pop-holing, drilling, etc., needs no comment; therefore, as a suggestion in view of simplifying the steel equipment of the mine and its standardization that the same ⅞-in. quarter-octagon, collared drill-steel recommended for other machines employed for sinking, light drifting, breast stoping, and pop-hole drilling be employed for all pneumatic feed stoping-drills.

After the type and size of drill-steel bar and its shank is settled upon, careful consideration should be given to the change length and also to the gauge of the bit for the different steels that comprise a set to drill to a stated depth, it is recommended that a normal change length of 12 in. be adopted for the ⅞-in. collared quarter-octagon steel as applied to machines 1, 2, 4, 5, 7, and 8, an 18-in. change length for the 1½-in. cruciform, twisted solid steel as applied to machine 3, and a 24-in. change length for the 1¼-in. round, hollow lugged steel as applied to machine 6.

Importance of the Drill-Bit

Very often one of the biggest 'leaks' in a mine is to be found in the cutting end of the drill-bit and as this is the 'business' end of metal mining it is the logical starting point in the campaign to raise efficiency. The start should, therefore, be made, first, by selecting drill-steel of the required shape and quality for the work; secondly, by forging the bit end of the drill-steel to the required shape; and thirdly, by subjecting it to proper heat-treatment.

Heretofore, many mine operators have adopted the practice of hiring a blacksmith or drill-sharpener, bestowing upon him the responsibility of keeping the mine supplied with drill-steel and have trusted to the 'four-leaf clover' that they carry around in their notebooks, for results. Under such conditions they usually get them, but they are not as a rule of a kind that justify the signification of the 'four-leaf clover.'

The material from which the drill-steel is made should be selected to meet the existing conditions of the work, after which the selection should be rigidly adhered to, and a standard method of procedure adopted for working it. Metallurgy has made such rapid strides that it is now a comparatively simple matter to secure the chemical composition and physical

characteristics of any particular kind of steel which, after being determined, should be used as the basis of a standard set of specifications. There is nothing more disconcerting to the drill-steel smith than to be forced to work steel of varying chemical composition that invariably is found about at the mine where material is purchased from several sources, with no more rigid specifications than the mere statement that hollow or solid drill-steel is what is wanted.

Sharpening Drills at Correct Heat

After the material is standardized for the work, smiths should be taught to forge the material at a safe working heat. All blacksmiths know that the hotter steel is heated preparatory to forging the earlier will be the work of hammering it into shape; while but few realize the disastrous effect of overheating, which is detected only when the finished drill-bit is subjected to service perhaps in an inaccessible working place a mile or two underground and away from the shop. Then it is usually the steel that is condemned instead of the real cause of trouble being determined and checked.

The next important lesson that the blacksmith should be taught is the fact that in the operation of tempering or heat-treating, all straight carbon drill-steel should be quenched when heated to the critical point regardless of the method employed for drawing the temper. It is called the critical point, because it is the point in the temperature of the piece being heated at which a change takes place in the structure of the steel due to the carbon being dissolved. It is the point below which steel will not harden when quenched, and by coincidence it is the point at which the steel loses its magnetism.

When high, straight carbon-steel is heated to the critical point, and cooled rapidly by quenching in ice-cold water, maximum hardness and density is obtained; and it must be remembered that density of structure is equally as important a factor as hardness in rendering the tool both shock and wear-resisting. The required degree of toughness is secured by varying the rate of cooling, when the piece is quenched at the critical temperature, and as applied to the cutting point of the tool, this must be varied to suit the requirements of the work.

For the shank or striking-end of the tool, density and toughness are more to be desired than hardness, so for general work

the desired result may be secured by heating to the critical temperature the entire shank-end for a short distance below the collar or shoulder, dipping the tip-end in cyanide of potassium and then quenching in oil, allowing it to remain there until cool.

Effect of Over-Heating Steel

Let us consider the resultant effect of operating on a drill-steel that has been injured in the smith's shop. Regardless of whether it has been over-heated preparatory to forging, over-heated preparatory to quenching, or quenched at too low a heat, the general result is the same. The cutting end of the tool is rapidly dulled in service, due to the absence of wear-resisting qualities. It loses its ability to penetrate the rock when struck, so that the shock must of necessity be absorbed in the steel itself, or transmitted back to the actuating engine. The effect of continued hammering with a dulled cutting tool upon the rock is exactly the same as that of operating against an impenetrable substance such as a hardened anvil. Minute fatigue-checks are established throughout the length of the drill, and as the strength of a chain is determined by its weakest link, the ability of a piece of steel to withstand vibratory shock is determined by its weakest point. It is at this point that one at least of the fatigue-checks will have been established. Initially, it may be so small as to be hardly detectable by the naked eye, but with continued operation it gradually grows larger by assuming a semi-circular or arc-shaped appearance, extending into the body of the material. As this check enlarges it is caused to open and shut as the vibratory stresses to which the cutting tool is subjected affect it. Eventually, the steel or cutting tool is broken apart with the balance of the section, disclosing a good, clear fracture of the metal in its original condition.

Unfortunately the effect of the abuse to which the drill-steel or cutting tool is subjected, does not as a rule end with the initial fracture of the bar. When a drill-steel breaks apart in service, the shorter end only is as a rule discarded and the longer is set aside to be either re-shanked or re-sharpened at the convenience of the drill-steel smith. A defective piece of steel is thus again put in commission, and often is broken again in service before it is subjected to undue shock.

The effect of operating on a dulled drill-bit is not confined to the cutting tool, for it must be remembered that the cushioning effect due to the penetration of the chisel in the material worked upon, alone makes possible the successful operation of every part comprised in the make-up of the rock-drilling engine.

Standardization of Hose and Hose Fittings

It is recommended that the inside diameter, outside diameter, length, and type of hose employed for supplying the rock-drill with air and water under pressure should be standardized, and the following suggestions are advanced with this in view.

For the air supply of machines 1, 2, 3, 4, 5, 7, and 8, ¾-in. plain pneumatic hose, without wire winding.

For the air supply of machine 6, a 1-in. plain pneumatic air hose without wire winding.

The length of all air-supply hose to be 50 feet.

For the water supply of all machines ½-in. half round wire-wound hose.

The length of water hose to be 25 feet.

My suggestions relative to the standardization of hose fittings for hammer rock-drill service were embodied in an article that was published in the *Engineering and Mining Journal* of June 5, 1920.

Standardization of Mining Columns for Hammer Rock-Drills

Of the hammer rock-drills recommended, two only require mountings, namely, 5 and 6. In order to keep the saddle of the mining columns limited to two sizes, and incidentally provide the required strength of column for the varying conditions of use, the following is recommended:

For machine 5, a 2½-in. single-screw column with 2½-in. arm when single drill is employed, and 3-in. double-screw column with 2½-in. arms when two drills are used on the same column.

For machine 6, single-screw column with 3½-in. arm when single drill is employed, and 4-in. double-screw column with 3½-in. arms when two drills are used on the same column.

PRELIMINARY INVESTIGATION ON THE STANDARDIZATION OF DRILLING-MACHINES AND DRILL-STEEL

Prepared Under the Direction of ARTHUR NOTMAN, Superintendent, Mine Department, Copper Queen Branch, Phelps Dodge Corporation, Bisbee, Ariz. (Member of the Sub-Committee on Drilling-Machines and Drill-Steel).*

Standardization of Rock-Drill Fittings

interchangeable between many of the machines of the manufacturer, but also to have the rock-drill companies adopt the same specifications in making these minor parts. At the present time this condition is far from realization.

For example: in the case of water and air spuds, the only course for a large mining company to pursue today is to accept the product of one manufacturer as the standard. This means scrapping the spuds on many of the newly-purchased machines. Though such a standard has been adopted at the Copper Queen Branch of the Phelps Dodge Corporation, it requires three sizes of water spuds to fit out the three types of Ingersoll-Rand machines in use. They must be machined down or bushed up to fit other makes. A change in this condition would greatly benefit mining companies, and it would work no hardship upon rock-drill manufacturers.

The following discussion is based upon the principle that differences in the sizes of bolts, nuts, and spuds should be reduced to a minimum. It is important that as few wrenches as possible be needed to operate the machine. The more wrenches required, the greater will be the chance of losing them underground, as well as loss of time on the part of the miner in operating the machine. It must be realized that in drifting, only about 30% of what is charged as drilling time is actually spent with the bit hitting the face. Through standardization, the operating efficiency should be slightly

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*This report, according to Mr. Mitke, must in no way be considered as the report of the Sub-Committee on drilling machines and drill-steel, but are merely the individual views of two members of the Committee, and as such contain much valuable data. Mr. Braly, Chairman of the Committee, reported that while considerable work had already been accomplished, the Committee, as a whole, was not yet ready to submit a report.

increased. An additional advantage would be the reduction in the number of repair parts to be carried.

The chuck-wrench is the chief tool used in operating drifting machines. As many nuts should fit this wrench as is practical. The monkey-wrench should be eliminated, because it is expensive and unsatisfactory. It must be admitted that it is a very handy tool, but underground conditions cause rust to ruin the threads long before actual hard usage would necessitate scrapping. Stillson wrenches are too valuable for other purposes to remain long on the job, unless owned by the operator, and are also subject to damage from corrosive water.

While many of the following suggestions may seem radical, they are offered in the hope that they will help to bring about a much-needed standardization.

Suggested Improvements in Machine-Drills

(1) Larger oil reservoirs, if practical, would reduce troubles due to lack of lubrication by lessening the responsibility of the operator in this regard. At present, the tendency of rock-drill manufacturers seems to be to make the lubricators too small.

(2) Some of the latest type rock-drills call for both grease and oil. Requiring two kinds of lubricant is a disadvantage, as it adds one more duty to the miner. In the past, the drill-runner has not proved himself able to handle even one oil-can, to say nothing of two.

(3) With the introduction of wet machines, the tendency has been to develop drifting rounds with an increased number of upper holes. In the Copper Queen mines, practically all of the drifting is done with the standard V-cut round, using either 16 or 13 holes. About 85% of the drifts require 16 holes to break the ground. The 16 and 13-hole rounds have 9 and 7 holes, respectively, drilled from under the arm. This means that plugs in the lubricators should be so placed as to allow filling when the machine is in either the over or the under-arm position. It is acknowledged that doubling the number of plugs doubles the chances of their working loose and getting lost. To place the extra oil-plugs properly will require a slight extension of the lubricator castings.

(I wish to make no apology for any attempt to show drill manufacturers how to change their design, or to do any of these things, because I do not pretend to know. This is merely offered as a suggestion and without any right of opinion in the matter.)

Lubrication

The under oil-plugs should be on the opposite side of the rock-drill from the hose connections. In any event, some means should be devised for lubricating the machine in this position.

Under present conditions, what little oil a drifter gets when it is under the arms, comes through the hose, as few men will take the time or trouble to lossen the clamps and 'dump over' their machine to permit filling the lubricators. Even to oil through the hose means two trips to the air head, which generally results in the machines running dry most of the time. The under-arm position comes in the last half of the shift, when time is inclined to be short, and lubrication is forgotten as long as the piston moves. It is unnecessary to more than mention the fact that sufficient lubrication is very necessary with the modern high-speed machines.

To comply with the safety regulations, the stoper handles should point down; the end of the handle can be enlarged to form a rest for the driller's hand. If the handle must extend upward, it should be bent to extend over the arm. In this case, the handle length must be somewhat greater than the average width of a man's hand.

The position of the stoper handle leads up to the location of the oil-plugs. At present, the usual place for the plugs is at the end of either the arm or handle. All oil-plugs should be placed in such a position as to allow filling of the lubricators when the stoper is in the running position. This would ensure more frequent oiling. The necessity of having to lay the stoper on its side, or turn it upside down, to fill the oil-cups, does not work toward sufficient machine lubrication.

With some of the new mechanically rotated stopers, the forward oiling or greasing point is in no sense an oil reservoir. The opening is really nothing but a hole into the machine, and it is valueless as regards lubrication.

Position of Fittings

(4) Some of the self-rotating stopers exhaust at right angles to the machines. Not confining the exhaust to a breeching reduces the back pressure and the tendency to freeze.

The direct exhaust certainly is a mechanical advantage, but on the other hand, it is a handicap to the drill-runner, who must keep his light from being blown out. From the miner's point of view, the exhaust along the feed cylinder is the most satisfactory. However, side exhaust on a self-rotator is not as objectionable as it should be on a 'wiggletail.'

(5) It is possible that it might be more satisfactory to disregard the oil reservoirs on the plugger-drills and go back to the lubricating throttle-valves. This will depend on the capacity of the machine oil-cups and the cost of the valves.

(6) On the drifters, the air and water connections should be on the same side of the back head, and yet not interfere with removing the side-rod. Probably it is better to have the connections on the right (exhaust) side of the machine.

If one connection is made through the rear of the back head, the hose gets in the way of the crank-handle when changing steel. If the hose connections are on opposite sides, they interfere with moving close to the column to drill the center-line holes.

The question of which side both the spuds should be on is somewhat a matter of choice, depending upon the shape of the back of the drift, and whether the operator is right or left-handed. This is the case since the side next to the column, when the machine is over the arm, is the far side when the machine is under the arm. When possible, it is better to collar the top center-line holes on center and swing the lower ones to bring their bottoms on line.

Design of Chuck-Wrenches

(7) It is essential to have a chuck-wrench that fits all of the frequently used nuts and fittings about the drill which are used in rotative operations. Those parts are the nuts on the arm, collar, clamp, and swing bolts. It is also important that the small end of the chuck-wrench should fit the water connection nut, oil-plugs, and the back-head cap. This wrench

should be double-ended and of proper design. The weight of the wrench should be between 5½ and 7 lbs., and it should be strong enough to withstand being used as a hammer. Pounding of the machine should not be tolerated, but the compromise of occasionally hitting the drill-steel seems to be a necessary evil. A chuck-wrench with jaw openings of 1 15/16 and 1 5/16 in. has proved satisfactory in the Copper Queen mines.

If the chuck-wrench had attached to it a short chain with a thin ring over the swing or arm-bolts, it would help increase efficiency when drilling over the arm. The chain must be attached to the wrench by a sliding link; the ring to hang on the bolts should be 2 inches in diameter.

(8) To move the smaller nuts about the drifters, at least one other two-ended wrench will be required. These two will be all that are needed, if the ½-in. valve-chest and side-rod bolts can be eliminated from a few types of machines. It may be that the miner will have but little need of the smaller wrench, except occasionally to tighten the side-rods of certain types of drills. If it were possible to handle the side-rods with the chuck-wrench it would be a big advantage. Perhaps this can be done by locking the side-rod nut instead of the bolt, and enlarging the bolt-head to fit the small end of the wrench. With some machines, the bolt-head is in too tight a place to permit turning with chuck-wrench. Even then nothing would prevent the use of the enlarged bolt-head, though the small wrench would have to be used on the nuts.

It may be possible to combine the box-wrench with either of the two double wrenches, by placing it between the jaws to be used in withdrawing the steel from the hole.

Bolts and Threads

In the suggestions that follow, all bolts referred to should have U. S. Standard bolt threads. For various bolt dimensions, the table given below lists the thread per inch and the width in inches, across the flats of hexagon and square nuts, according to U. S. Standards.

Diameter of bolt—inches	Threads per inch	Width across flats of hexagon and square nuts, inches—rough	Width across flats of hexagon nuts, inches—finished
1⅛	7	1¹³⁄₁₆	1¾
1	8		
⅞	9	1⁷⁄₁₆	1⅜
¾	10	1¼	1³⁄₁₆
⅝	11	1¹⁄₁₆	1
½	13	⅞	¹³⁄₁₆
⁷⁄₁₆	14	²⁵⁄₃₂	²³⁄₃₂
⅜	16	¹¹⁄₁₆	⅝
⁵⁄₁₆	18	¹⁹⁄₃₂	¹⁷⁄₃₂
¼	20	½	⁷⁄₁₆

BRIGGS PIPE-THREADS

Pipe diameter—inches	Threads per inch
⅜	18
½ and ¾	14
1 to 2	11½

The taper of threads is ¾ inch per foot

As to the shape of nuts used, the square ones are more durable and, when practical, should be adopted as standard. If necessary, the square nut can always be replaced by the hexagon, except in a few cases, such as on the arms, clamp, swing, and a few other bolts.

Water-Hose Connection

The same size water-spud should fit all machines. A standard pipe-thread should be on the machine side of the spud. The connection with the water-hose should be made with parallel threads on account of excessive wear due to frequent breaking of connection. The head on the water-spuds might be round to prevent unnecessary tinkering with it by the machine-man.

The nut to fit the water-spud should be of hexagon shape and 1¼ in. across flats. It is very important that this nut should fit the small end of the chuck-wrench.

In practice, the water-spuds seem to wear out long before the nuts. The nut should be made of the softer material as it should be the first to need replacing. The spud, while easier to change, is the more expensive.

Table No. 1 gives some data on the water-spuds and nuts that are now on hand.

TABLE No. 1

I-R SPUDS

Used on	Spud-Head Shape and inches across flats	Pipe-thread—inches	Spud: To machine Taper threads per inch	Spud: Threads per inch	Spud: Hose end Diameter—inches	Parallel threads	Nut across flats—inches
Plugger	Round 1⅝	1+	1 1/16	13	1 3/16	10	1½
Stoper	Hex. 1½	½	13/16	14 (Std.)	1 3/16	10	1½
Leyner	Hex. 1½	¾	1-in. parallel	14	1 3/16	10	1½
SULLIVAN SPUDS							
Plugger	Hex. 1¼		1 9/32	12	1	12	1¼
Stoper	Hex. 1¼		⅞	12	1	12	1¼
WAUGH SPUDS							
Stoper	Hex. 1¼		13/16	14	1¼	12	1⅜

Each of the six spuds listed above are different in detail. As stated before, it takes three sizes of I.-R. water-spuds to rig out the various types of I.-R. machines alone in use in the Copper Queen mines. Only the Sullivan water-spud nut fits the chuck-wrench. For convenience, the I.-R. has been adopted as standard, but must be machined down or bushed up to fit other makes.

Water-Needle Connection

It is often a hard job to remove the back-head cap with a monkey-wrench. The cap should be haxagon shaped and 1¼ in. across flats. This size cap can be handled by the small end of the chuck-wrench. The same size back-head cap and plug should be on the drifters, pluggers, and even the stopers, when the needle is held in place by the cap and plug method. The plugger handle standards should be wide enough to permit the use of the chuck-wrench on the back-head cap.

The head of the back-head plug should be so shaped as to fit the ⅜-in. bolt end of the small nut-wrench.

The combined back-head plug and cap is an improvement over the two separate fittings. The threads on the back-head cap and plug need not necessarily be standard ones.

TABLE No. 2

BACK-HEAD CAP AND PLUG DETAILS

Machine	Cap outside — Cap.			B. H. gland gasket—inches	Plug — To cap			Plug — To machine	
	Across flats—inches	Diameter threads—inches	Threads per inch		Diameter—inches	Threads per inch	Inches across plug	Diameter—inches	Threads per inch
Clipper	7/8 Hex.	7/8	14	3/4 by 3/8		No Plug			
{ Waugh Turbro	1 1/4 Hex.	7/8	14			No Plug			
DP 33	1 7/16			3/4 by 5/8	1 1/8	12	7/8	1	12
Jackhamer	1 1/4			5/8 by 1/2	1	12	5/8	1	12
NRW 93	1	1 1/8	12	7/8 by 3/8		No Plug			
DX 61	1 1/4			3/4 by 3/16	3/4	10	1 1/16 sq.	1 3/16	12
550 D	1 1/4			5/8 by 1/2	1	12	5/8	1	12
13 Leyner	1 1/2			3/4 by 5/8	1 3/16	10	3/4	1 3/16	10
148 Leyner	Same as 18 Leyner								

Of the above listed back-head caps those on the Waugh Turbro, DX 61, 550 D, and the Jackhamer, will fit the small end of the chuck-wrench. The B. H. plugs on the 550 D and the Jackhamer could be handled with the 3/8-in. bolt-wrench. The 148 and 18 Leyner back-head plugs are the same and those on the 550 D and Jackhamer are alike.

No doubt these important parts can be standardized. Similarly, of the nine water-needle connections examined, those on the 18 and 148 Leyners are the same and those on the 550 D and Jackhamer drill.

Oil-Plugs

One of the features of an ideal oil-plug is that it will not shake loose with the vibration of the machine. The diameter of the plugs should probably be about 7/8 in. Standard bolt-threads will hardly do for the plugs. Whether the threads should be tapered or parallel, is perhaps a matter not fully determined. The coarse threads seem to have gained more favor here than the fine ones. If the oil-plugs that have the eight parallel threads per inch had a split-lock washer hold between the threads and head they might prove efficient. The leather gaskets cause the plugs to hold, but as they fit tightly when new and are difficult to put in place, it is impossible to get the drill-runners to use them. A lubricator plug that would require only hand tightening would be a big improvement.

One size of oil-plug can be made to do for the drifters, stopers and pluggers.

The lubricator plugs should be handled by the small end of the chuck-wrench.

A hexagon-shaped head 1¼ in. across flats would fit the chuck-wrench, and yet take no more room than the plugs now used on the I.-R. drifters. The present form of head with the hole affords a means of strapping the plug to the drill. If the hole is necessary, both the hexagon and present type of head can be combined.

TABLE No. 3

OIL-PLUG DATA

Machine	Plug diameter—inches	Threads per inch	Width of head—inches
DX 61	⅝	18—Taper	
Turbro	⅝	12—Parallel	
18 Leyner	⅞	12—Parallel	½
550 D	⅞	12—Parallel	⅜ and ½
148 Leyner	⅞	12—Parallel	
CC II	1	14—Parallel	
71	⅝	18—Taper (Special Bushing)	
DP 33	⅝	18—Taper	
NRW 93	⅝	18—Taper	
BCRW 430	⅝	12—Parallel	
Clipper	⅝	18—Taper	

The above figures show that there are listed three sizes of Ingersoll-Rand plugs. The Sullivan and Waugh reservoir plugs are interchangeable.

Hose Clamp-Bolts

The sizes of the bolts and nuts now furnished with the hose clamps are:

DIXON HOSE CLAMPS

Hose—inches	Bolt—inches	Nut	Nut across flats—inches
1	7/16 by 2	Square	23/32 finished
¾	⅜ by 1½	Square	⅝ finished
½	5/16 by 1¼	Square	17/32 finished

SULLIVAN HOSE CLAMPS

Hose—inches	Bolt—inches	Nut	Nut across flats—inches (hex.)
1	⅜ by 2¼	Hexagon	11/16 rough
¾	⅜ by 1¾	Square	11/16 rough
½	⅜ by 1¾	Square	11/16 rough

With the Sullivan clamps, two lengths of bolts are needed for the three sizes of hose. The Dixon make calls for three different bolts varying in both diameter and length.

The hose-clamps should be so made that one size of bolt will do for the three hoses. When the clamp is in place on the hose, the end of the bolts should not project more than ⅛-inch beyond the top of the nut. A bolt that is a little long for the smaller clamps could be easily cut off after being put in place on the hose.

It is recommended that the clamps for 1, 3/4, and 1/2-in. hoses be designed to use 3/8 by 2-in. bolts with square nuts. If this is done, the hose-clamps, crank, and throttle-bolts will be the same.

Drill-Column

The 3 1/2-in. drill-column seems to be large enough for any one-man drill. For the drifters, the double-jack column is preferred. The 3-in. mounting would do for the mounted plugger-machines.

The details of the connection between the column-pipe and cross-bar should be standardized.

The 3 1/2-in. double-jack column is the only one in use in the Copper Queen mines.

3 1/2-Inch Column

The jack-screws and nuts should be of some accepted design and size. The details of the jack-screws used in the Copper Queen mines are square threads, with 3 threads per inch, and the diameter of jack-screw of 1 3/4 inches.

The holes in the screw-heads should be not less than 1 inch in diameter.

The cross-bar must be long enough to allow the arm and safety-collar to pass between the jack-screws and column-pipe.

The bolts that clamp the pipe to the cross-bar should be the same size as the safety collar-bolts, that is, 3/4 by 5 in., with the regular square-shaped nut.

3 1/2-Inch Arm

The arm-bolts should be 1 1/8 by 6 1/4 in., with square nuts. The bolts now used on the arm have the regular square head.

3 1/2-Inch Clamp

The 5-in. cone should be taken as standard. The bolts now used with the I-R clamps are:

Clamp	1 1/8 by 6 1/4 in.	Square head	Extra long sq. nut
Clamp	1 1/8 by 6 in.	Bevel head	Extra long sq. nut
Swing	7/8 by 4 in.	Bevel head	Sq. nut 1 1/4 in. across flats
Jaw-bolt	5/8 by 3 3/4 in.		3/4 hexagon nut

For the sake of standardization, if the bevel head-bolt is sufficiently strong, the arm and clamp-bolts can all be of the bevel-head type—$1\frac{1}{8}$ by $6\frac{1}{4}$ in. The extra long nut is necessary for strength to provide a wide seat for the large end of the chuck-wrench.

The swing-bolt nut now in use is a special nut $1\frac{1}{4}$ in. across the flats, and therefore takes the small end of the chuck-wrench. If the width across the flats of this nut were increased to fit the large end of the wrench, it would no longer require both ends of the wrench to handle the swing and clamp. The thickness of this nut should be between 1 and $1\frac{1}{4}$ inches.

$3\frac{1}{2}$-Inch Safety Collar

The safety collar bolts should be $\frac{3}{4}$ by 5 in., and interchangeable with the column cross-bar bolts. The nuts should probably be the standard square ones. A larger nut to fit the big end of the chuck-wrench would mean another special, and would necessitate a shoulder on the collar casting; otherwise it would be an improvement.

Drifter Cradle

Some standard shape regarding depth, width, length, and distance between standard rod centers, guide-slide dimensions, etc., should be adopted. It is possible that there should be two standard shells—the narrower and lighter one being used with the smaller machines.

The adjustable guide-slide, with 'shims' to take care of wear, offers advantages. Instead of having the caps bolted on, would it not be better to replace the bolts with rivets?

The ends of the shell need to be reversible as regards the position of the crank.

Table No. 4 gives some information regarding a few of the shell castings now in use.

TABLE No. 4

Cradle	Total length of shell casting—inches	Center line between standard rods—inches	Inches between outside of guide-slides	Guide slide dimensions—inches	Type of screw support	From shell bottom to center of feed-screw—inches	Total length of feed-screw support—inches	Size of forward screw support bolt (inches) and type of nut	Reversible
Waugh Plugger	26¼	3⅝	3⅞	⅜ by 11/16	Vertical	1⅛	3⅛	¾ Hexagon	No
Waugh Clipper	26¼	3⅝	3⅞	⅜ by 11/16	Vertical	1⅛	3⅛	¾ Hexagon	No
Jackhamer	30¼	3¼	3⅜	7/16 by 9/16	Horizontal	1¼		⅝ by 2½ Hexagon	No
DX 61	26	3 13/16	4 9/16	9/16 by 1	Vertical	1¼	3 5/16	⅝ Hexagon	Yes
Waugh Turbro	26¼	4½	4½	½ by ¾	Vertical	1¼	3⅛	¾ Hexagon	Yes
18 Leyner	27¾	4¼	4¾	½ by 1	Vertical	1¼	3¼	⅝ Hexagon	Yes
248 Leyner	27¾	4¼	4¾	½ by 1	Vertical	1¼	3¼	⅝ Hexagon	No
550 D	27¼	4¼	3⅞	½ by ¾	Horizontal	1¼		⅝ by 1¾ Square	No
148 Leyner	27¼	4¼	3⅞	½ by ¾	Horizontal	1¼		⅝ by 1¾ Square	No

The above data shows that the shell castings of the Waugh Plugger and Clipper, the 18 and 248 Leyners, and the 550 D and 148 Leyners are the same. In the nine shell castings examined, there are six different ones.

Standard Rods

There probably should be two standard lengths of cradle standard rods. The length of rod will vary with the length of steel change. The diameter of the standard rods should be 5/8 in.; square hexagon nuts should be on the cross-head end.

If the side and cradle standard rods can be made, to some extent, interchangeable, the standard rods should be threaded on one end; if not interchangeable, the standard rods should be threaded on both ends.

If the standard rods are to be made interchangeable, they should be of the same material and given the same treatment in manufacturing as the side-rods. The advantage of having these two parts the same is that it makes one less rod to order and carry in stock.

Table No. 5 gives some data pertaining to the standard rods on several makes of cradles.

The above figures show no reason why the standard rods cannot be easily standardized. With the exception of the DX 61 cradle, the maximum difference in length of the standards is 5 in. The DX 61 rod extends along the entire length of the shell casting.

Feed-Screws

The details of the feed-screw such as the diameter, pitch, depth, and type of threads, diameter of the shafting at the forward and cross-head support, and diameter and pitch of the threads at the crank connection, should all be standardized. There must be about three standard lengths to correspond with the lengths of shell standard rods.

In regard to the kind of threads, both the V and square type have their advantages. Either form could be accepted as standard. The square threads check more easily and therefore develop less vibration on the crank-handle. However, the square threads finally wear to the V shape and are more easily stripped.

TABLE NO. 5

Cradle	Standard Rods: Size of Bolt, Inches	Type of Nut	Remarks
Waugh Plugger	5/8 by 17	Hexagon	Threads on both ends; nut on one end
Waugh Clipper	5/8 by 17	Hexagon	Threads on both ends; nut on one end
Jackhamer	(Cross-head bolt)	Hexagon	
	5/8 by 2½	Hexagon	
DX 61	5/8 by 44½	Hexagon	Nuts on both ends.
Waugh Turbro	5/8 by 20	Hexagon	Threads on both ends; nut on one end
18 Leyner	5/8 by 22	Hexagon	Nuts on both ends.
248 Leyner	5/8 by 22	Hexagon	Nuts on both ends.
550 D	5/8 by 22	Hexagon	Nuts on both ends.
148 Leyner	5/8 by 22	Hexagon	Nuts on both ends.

TABLE NO. 6

FEED SCREW DATA (DOUBLE THREADS, 2 PER INCH)

Cradle and Shape of threads	Approx. dia. of feed-screw inches	Approx. depth of feed-screw threads, ins.	Total length of feed screw ft. in.	Forward Screw support shafting diameter inches	Forward Screw support shafting Type	Dia. rear (cross-head) support shafting, Inches	Crank Connection dia. of threads, inches	Crank Connection Threads per inch
Waugh Plugger, Square	1 3/32	7/64	3–3	3/4	Open	1	1	12 } Same
Waugh Clipper, Square	1 3/32	7/64	3–3	3/4	Open	1	1	12 }
Jackhamer, Square	1	1/8	2–10½	1 1/16	Open	1	1	8
DX 61	1 3/32	7/64	3– 8⅛	1 3/16	Open	1	1	8
Waugh Turbro, Square	1 3/32	7/64	3– 6½	3/4	Open	1	1	12
18 Leyner, Square	1 3/32	3/16	3– 7½	5/8	Open	1	1	8 } Same
248 Leyner, Square	1 3/32	3/16	3– 7½	5/8	Open	1	1	8 }
550 D, "V"	1 1/16	3/16	3– 9	5/8	Open	1	1	8 } Same
148 Leyner, "V"	1 1/16	3/16	3– 9	5/8	Open	1	1	8 }

The double-threaded screw, with two threads per inch, seems to be in general use. Table No. 6 shows the diameter of the feed-screw threads in the nine cradles examined to vary between 1 and 1 3/32 inches.

The above figures show that in examining the nine feed-screws listed, there are two types of threads, three different diameters of screws, three depths of threads, six lengths, five different sizes of shafting at the forward support, and two different pitches of threads at the crank connection. In all nine sizes, the diameters of the shaft at the cross-head bearing and crank connection are 1 inch. With the exception of the Ingersoll-Rand plugger cradle screw, all the others are nearly the same in detail. There are six different feed-screws out of a total of nine.

All the figures given in Table No. 6 may not be exactly correct, as some of the parts measured were not new, and wear may have developed.

It is recommended, as mentioned before, that there be three standard lengths of feed-screws and that the type, pitch, and depth of threads be also standardized. The diameter of the front support shafting should be fixed between 5/8 and 3/4 in. The specifications should call for the feed-screw shaft to be 1 inch diameter at the cross-head and at the crank connection. The threads to the crank should be the standard U. S. bolt threads, which are eight per inch.

Forward Feed-Screw Support

Either the horizontal or vertical type can be accepted as the standard form of support. It should be made according to the assumed standard specifications regarding size of bolts, shape of nuts, total length, and height of bearing above the shell bottom. Table No. 4 gives some information of these details. Of the nine cradles examined, there are six supports that differ slightly in construction.

Regardless of which type of support is taken as the standard form, the bearing for the feed-screw shaft should be open at both ends. The bolts needed to hold the support to the shell casting should be 5/8 in. diameter, with square nuts.

If this fitting is necessary, it might be an improvement if it were riveted instead of bolted to the shell. At the Copper Queen mines, this part of the cradle does not last very long, as it is taken off by the drill-runner during the first shift.

Cross-Head

The cross-head should be made according to some accepted standard regarding thickness, diameter of bearing for feed-screw shaft, and distance between holes for standard rods.

Crank, Crank and Throttle-Handle Bolts

The actual shape of the crank and handle makes but little difference.

The threads to fit the 1-inch feed-screw shafting should be the standard of eight per inch. The feed-screw connection should be open at both ends.

Table No. 7 gives some data on the types and sizes of crank and throttle bolts now in use.

This table shows that each drill manufacturer uses a different size of crank-bolt; out of eight throttle-handle bolts, three are alike.

From the above table, it looks as if the throttle handle and crank-bolt could be standardized and made interchangeable. While the heavier crank-bolts with the special threaded heads may have their advantages, yet the 3/8-in. bolt on the Waugh Turbro crank seems to answer all purposes. It is suggested that the standard throttle and crank-bolt should be 3/8 by 2 in., with square-shaped nuts.

Plugger-Cradle

If the plugger machine is the regular form of shell plus a mounting slide, the cradle itself should coincide with one of the standard drifter cradles. The diameter of the bolts that help to form the forward and rear mounting slide clamps, should be 5/8 inch.

If the plugger-cradle is of the slide-extension type, the feed-screw should be the shortest adopted length of the standard feed-screw. The forward and rear clamp-bolts should be the same size (5/8-in. diam.), as the corresponding bolts on the

TABLE NO. 7

Cradle	Crank Bolt Size, inches	Crank Bolt	Crank Bolt Shape of nut	Machine	Throttle-Bolt Size inches	Throttle-Bolt Shape of nut	Shape and size inches, of throttle-valve stem
Waugh Plugger........	3/8 by 1 7/8		Square				
Waugh Clipper..........	3/8 by 1 7/8		Square				
Jackhamer..................	5/8 by 1 3/8	Special threaded head	Hexagon				
DX 61........................	1/2 by 2 1/8		Hexagon	DX 61	7/16 by 1 5/8	Hexagon	1 1/16 round
Waugh Turbro..........	3/8 by 1 7/8	Special threaded head	Square	Waugh Turbro	3/8by 1 3/4	Hexagon	5/8 square
18 Leyner..................	5/8 by 1 3/8	Special threaded head	Hexagon	18 Leyner	3/8 by 1 5/8	Hexagon	5/8 Square
248 Leyner	5/8 by 1 3/8	Special threaded head	Hexagon				
550 D........................	5/8 by 1 3/8	Special threaded head	Hexagon	550 D	3/8 by 1 5/8	Hexagon	5/8 square
148 Leyner................	5/8 by 1 3/8	Special threaded head		148 Leyner	3/8 by 1 5/8	Hexagon	5/8 square
				71 Waugh stoper	7/16 by 2	Hexagon	1 round
				16 "V" Waugh	3/8 by 2	Hexagon	1 round
				CC 11 I-R Stoper	(cotter key 3/16 by 2)		5/8 square

other type of plugger machine cradle. The slide-bolt should be the standard 3/4-in. bolt with a square nut.

It would make one less part to order, if the 3/4-in. slide and safety collar-bolts were of the same length. At present the slide-bolt is 2 1/2 in. the longer.

Table No. 8 shows some figures pertaining to the plugger-cradles.

The above figures show that three out of four sets of mounting clamps require different sizes of bolts. The Jackhamer system of mounting is probably the best, only the eye-bolt should be replaced by one with a regular head. It is possible that by slightly widening the crank end of the Jackhamer shell casting, the need of a cut head-bolt for the cross-head can be avoided. The size of the cross-head and mounting slide forward clamp-bolts can probably be the same (5/8 by about 2 1/2 to 3 in.), though this is a matter of small importance. The size of the rear clamp-bolt can probably be standardized at 5/8 by 5 to 6 inches.

The nuts for the 5/8-in. cross-head bolts should be the regular square ones. The 5/8-in. mounting slide clamp-bolts must have special square nuts 1 1/4 in. across flats, as are provided with the I.-R. cradle. The special nut fits the small end of the chuck-wrench.

The details of the feed nut on the plugger-cradles should be the same as on the larger drifters.

Summary

An observation of Table No. 9, which is a combination of Tables No. 4, 5, 6, 7, and 8, shows that of the nine cradles listed, six are unlike. The cradles listed include the types that are required to mount practically all classes of rock-drills. By close standardization, the number of different cradles could be decreased to three, and probably two. The length of steel change, except with the I.-R. plugger-cradle, can be varied by using either of the two lengths of standard feed-screws.

It would be impossible to attempt to standardize the shape of the clamp-straps that hold the pluggers to the mounting slide.

TABLE NO. 8

Plugger Cradle	Cross-Head Bolt: Bolt size, inches	Cross-Head Bolt: Nut	Slide-Bolts: Bolt size, Inches	Slide-Bolts Nut: Shape	Slide-Bolts Nut: Inches across flats	Forward Clamp-Bolt: Bolt Size, inches	Forward Clamp-Bolt Nut: Shape	Forward Clamp-Bolt Nut: Inches across flats	Rear Clamp-Bolt: Bolt size, inches	Rear Clamp-Bolt Nut: Shape	Rear Clamp-Bolt Nut: Inches across flats
Waugh Plugger						½ by 6⅜ ("T" head)	Hex.	Reg.	½ by 4¾ (Special)	Hex.	Regular.
Waugh Clipper						½ by 4	Hex.	Reg.	½ by 3½	Hex.	Regular.
Jackhamer	⅝ by 2½ (Special head)	Hex.	¾ by 7½	Sq.	1¼	⅝ by 2¼ (Eye head)	Hex.	Reg.	⅝ by 5	Hex.	Regular.
Jackhamer	⅝ by 2½ (Special head)	Hex.	¾ by 7½	Sq.	1¼	⅝ by 2¼ (Eye head)	Hex.	1¼	⅝ by 5	Sq.	1¼ special

MACHINES

Machine Side-Rods

Table No. 10 gives some data regarding the side-rods on various machines.

This table shows that practically all the drifter and stoper side-rods are 5/8-in. bolts. The plugger machines have the 1½-in. side-rods.

It is thought that perhaps the bolts on the class of rock-drills considered in this paper can be limited in diameter to 5/8 and 3/8-inch. Is it practical to put 5/8 or 3/8-in. side-rods on the plugger drills?

From the figures in Table No. 10 it appears as if it would be possible to do some work in standardizing the side-rod bolts. In the list are included machines with rifle-bar, front-head, and turbine rotation. The smaller plugger side-rods are practically the same in all respects. There is little difference given between the lengths of the rods on the various drifters and stopers that have through side-rods.

A part standardization of the side-rod bolts would not affect the design of the drill to any extent. It would be possible, in many cases, to vary slightly the length of the spring as well as the position of the retaining lugs on the front-head forging. As mentioned before, the most commonly used length of side and standard rods could be more interchangeable. The nuts on the side-rods must be haxagon shaped.

Exhaust

The threads on the valve exhaust-port should be the ¾-in. standard pipe-thread.

Valve-Chest

In Table No. 11 is given some data pertaining to the valve-chest bolts. (See page 138.)

TABLE NO. 9

Cradle	CRANK-BOLT Size, inches	CRANK-BOLT Shape of nut	FORWARD CLAMP-BOLT Bolt inches	FORWARD CLAMP-BOLT NUT Shape	FORWARD CLAMP-BOLT NUT inches, across flats	REAR CLAMP-BOLT Bolt, inches	REAR CLAMP-BOLT NUT Shape	REAR CLAMP-BOLT NUT inches, across flats
Waugh Plugger	⅜ by 1⅞	Square	½ by 6⅜ ("T" head)	Hex.	Reg.	½ by 4¾ (Special)	Hex.	Regular.
Waugh Clipper	⅜ by 1⅞	Square	½ by 4	Hex.	Reg.	½ by 8½	Hex.	Regular.
Jackhamer	⅝ by 1⅜	Hexagon (Threaded head)	⅝ by 2¾ (Eye bolt)	Hex.-Sq.	Reg. & 1¼	⅝ by 5 or 6	Hex. & Sq.	Reg. 1¼
DX 61	½ by 2⅛	Hexagon						
Waugh Turbro	⅜ by 1⅞	Square						
18 Leyner	⅝ by 1⅜	Hexagon (Threaded head)						Same
248 Leyner	⅝ by 1⅜	Hexagon (Threaded head)						
550 D	⅝ by 1⅜	Hexagon (Threaded head)						Same
148 Leyner	⅝ by 1⅜	Hexagon (Threaded (head						

Cradle	FEED-SCREW Shape of double threads	Aprox. Dia. of feed-screw, inches	Approx. Depth of feed-screw threads inches	Total length of feed-screw ft. in.	Dia. of screw support shafting, inches	Dia. of Cross-head support shafting, inches	Crank Dia. of threads, inches	Connection Threads per inch	Standard Rods Size of bolt, inches	Standard Rods Type of nuts	Remarks
Waugh Plugger	Square	1 3/32	7/64	3– 3	3/4	1	1	12	5/8 by 17	Hex.	Threads on on both ends; nut on one end.
Waugh Clipper	Square	1 3/32	7/64	3– 3	3/4	1	1	12	5/8 by 17	Hex.	
Jackhamer	Square	1	1/8	2–10 1/2	1 1/16	1	1	8		Hex.	No standard rods.
DX 61	Square	1 3/32	7/64	3– 8 1/8	1 3/16	1	1	8	5/8 by 44 1/2	Hex.	Nuts on both ends.
Waugh Turbro	Square	1 3/32	7/64	3– 6 1/2	3/4	1	1	12	5/8 by 20	Hex.	Threads on both ends nut on one end.
18 Leyner	Square	1 3/32	3/16	3– 7 1/2	5/8	1	1	8	5/8 by 22	Hex.	Nuts both ends.
248 Leyner	Square	1 3/32	3/16	3– 7 1/2	5/8	1	1	8	5/8 by 22	Hex.	Nuts both ends.
550 D	"V"	1 1/16	3/16	3 –9	5/8	1	1	8	5/8 by 22	Hex.	Nuts both ends.
148 Leyner	"V"	1 1/16	3/16	3– 9	5/8	1	1	8	5/8 by 22	Hex.	Nuts both ends.

Cradle	SHELL CASTING Total Length of shell casting inches	Center line between standard rods, inches	Inches between outside of guide-slides	Guide-slide dimensions, inches	Type of screw support	From Shell bottom to center of feed-screw inches	Total Length of screw support inches	Size of Screw support inches; type of nut	Reversible
Waugh Plugger..	26¼	3⅝	3⅞	⅜ by 1 1/16	Vert. open	1⅛	3⅛	¾, Hex. No	Same
Waugh Clipper..	26¼	3⅝	3⅞	⅜ by 1 1/16	Vert. open	1⅛	3⅛	¾, Hex. No	
Jackhamer..........	30¼	3¼	3⅜	7/16 by 9/16	Horiz. open	1¼		⅝ by 2½ Hex. Yes	
DX 61..............	26	3 13/16	4 9/16	9/16 by 1	Vert. open	1¼	3 5/16	⅝, Hex. Yes	
Waugh Turbro..	26¼	4¼	4½	½ by ¾	Vert. open	1¼	3⅛	¾, Hex. Yes	
18 Leyner..........	27¾	4¼	4¾	½ by 1	Vert. open	1¼	3¼	⅝, Hex. No	Same
248 Leyner........	27¾	4¼	4¾	½ by 1	Vert. open	1¼	3¼	⅝, Hex. No	
550 D..............	27¼	4¼	3⅞	½ by ¾	Horiz. open	1¼		⅝ by 1¾ Sq. No	Same
148 Leyner........	27¼	4¼	3⅞	½ by ¾	Horiz. open	1¼		⅝ by 1¾ Sq.	No

TABLE NO. 10

Machine	Side Rod Size—Inches	Nut	Remarks
DRIFTERS:			
DX 61..................	⅝ by 7½ and 11½	Hexagon	Threads on both ends; nut on one.
Waugh Turbro..................	⅝ by 18¾	Hexagon	Threads on one end; head on other.
W Dreadnaught..................	⅝ by 23½	Hexagon	Special head.
18 Leyner..................	⅝ by 25	Hexagon	Head 1 in. square; three on one end.
550 D..................	⅝ by 17¼	Hexagon	Head on one end.
148 Leyner..................	⅝ by 21¼	Hexagon	Head on one end.
STOPERS:			
16 V..................	¾ by 13		Hollow rods.
CC 11..................	⅝ by 17½		
CC 11..................	⅝ by 7¾ and 9		Special head.
71 Waugh..................	⅝ by 17¾	Hexagon	Head 1 in. hex. on one end.
DT 42 and 44..................	¾ by 18		Hollow rod.
PLUGGERS:			
DP 33..................	½ by 13½	Hexagon	Threads on both ends.
NRW 93..................	½ by 12¼	Hexagon	
BCRW 430..................	½ by 13¾	Hexagon	
Waugh Clipper..................	½ by 18	Hexagon	Special head.

If the ½-in bolts are to be eliminated, the valve and motor-chest bolts will have to be ⅝ and ⅜ in. No standardization of these parts other than of the bolt diameter can be attempted. The special shaped bolt-heads should be avoided.

In the case of the 18 Leyner the valve-chest stud-bolts often turn when the nuts are moved. It would perhaps be an improvement if the valve-chest casting were slightly increased in width, and the ½-in. bolts replaced by ⅝-in. size.

Feed-Nut and Parts

The feed-nut washer and lock-nut should be of the design and size that was accepted as standard.

The following table lists some of the feed-nut details:

TABLE NO. 12

Machine	Total length, inches	Hexagon lock-nut across flats—inches
Waugh plugger	4	1¾
Waugh clipper	4	1¾
Jackhamer	4½	2
DX 61	4½	1$^{13}/_{16}$
Waugh turbro	4	1¾
18 Leyner	4¾	2
550 D	4¾	2
148 Leyner	4½	2

It would be a slight advantage if the lock-nut were about 1$^{13}/_{16}$ in. across flats. It would then fit the large end of the chuck-wrench.

On the I.-R. 550 D it is important that the needle-valve bushing and lock-nut can be handled by either the ⅝ or ⅜-in. wrench. The details of the bushing and nut are:

Part	Size, inches	Threads per inch	Heads across flats—inches
Valve bushing	$^{13}/_{16}$ by 1	14	⅞
Lock-nut		14	1⅛

As they are now made, the head on the valve bushing is too large for the ⅜-in. bolt-wrench, and the lock-nut head is $^{1}/_{16}$-in. too large for the ⅝-in. wrench.

Plugger Handle-Bolts

On page 139 are a few figures regarding the plugger handle-bolts.

TABLE NO. 11

Machine	Valve-chest Bolt: Size, inches	Valve-chest Bolt: Nut	Valve-chest Bolt: Remarks	Motor-chest Bolt: Size, Inches	Motor-chest Bolt: Nut	Motor-chest Bolt: Remarks
DX 61	None					
Waugh Turbro				3/8 by 3 1/4	Hexagon	Special head.
18 Leyner	1/2 by 3 1/2	Hexagon	Stud-bolt			
550 D	1/2 by 5	Hexagon		7/16 by 3 1/2	Hexagon	Special head.
148 Leyner	1/2 by 3	Hexagon	Special valve-spindle			
CC 11	1/2 by 2 1/2	Hexagon	Studs			
DP 33	1/2 by 5 1/2	Hexagon	Threads and nuts on both ends.			
NRW 93	3/8 by 2 7/8	Hexagon	Studs			
BCRW 430	3/8 by 2 3/4	Hexagon	Studs			
Clipper	None					

TABLE NO. 13

Machine	Bolt, inches	Nut
DP 33	½ by 13½	Hexagon
NRW 93	½ by 13½	Square
BCRW 430	¾ by 12½	Square
Clipper	½ by 15	Square

The diameter of the handle-bolt can probably be increased to ⅝-in. It looks as if a bolt ⅝ by about 1¼-in. could be taken as the standard. The nut should be square.

Air Connections

It is a matter of choice between the bent nipple and pipe fitting connection. The bent nipple is neater, and it probably offers less resistance to the air than does the same size connection made up of pipe fittings. The sharper the curvature of the nipple, the less room will be taken up by the fitting.

The size of the air connections will depend on the air consumption of the machine. The two standard sizes should perhaps be ½ and ¾-inch.

The air-swivel connection nut, or bushing, can probably be made one standard size to serve both, the ½ and ¾-in. fittings. The head of the swivel-nut should fit either the large or small end of the chuck-wrench. The shape of the head should be haxagon, with 1 13/16 or ¼-in. across flats.

There does not seem to be any reason why the threads on the swivel-nut cannot be made to correspond with standard pipe-threads. There is some doubt about the advisability of standard pipe-threads when the cylinder is a casting. Standard pipe-threads for the air connections are now used on many of the plugger and stoper-drills.

Parallel threads will have to be used on the hose nut end of the air-spud. No bushing should be needed to fasten the spud to the nipple or pipe fittings that lead to the drill. The hexagon head on the air-spud should be 1 13/16-in. across flats to fit the large end of the chuck-wrench.

The air-connection nut should be either of the lugged or hexagon type, and be of such size as to permit turning by the chuck-wrench if necessary.

The inside diameter of the hose should approach the size of the hose as nearly as possible.

Table No. 14 lists more information on the details of the air-swivel nut and air-hose spud.

This table shows that the swivel-nuts are interchangeable between the DT 42 and DT 44, also between the Waugh Turbro and 71 Drills. The Clipper, CC 11, NRW 93, and DP 33 require only the standard 3/4-in. pipe nipple to connect the air to the machine. None of the swivel-nut heads make an exact fit with the chuck-wrench.

The six air-hose spuds listed are all different. None of the spud-heads are the exact size to fit the large end of the chuck-wrench. That the I.-R. spud has not taper threads to the nut is the only difference between it and Briggs standard 1½-in. pipe fitting. Parallel threads are necessary on account of excessive wear from frequent use.

Air-Filter

The form of air-filter is a matter of choice. In some of the T-shaped types it is too easy a matter to remove the screen. The T filter with a plug promotes oiling through the hose.

The I.-R. air-filter No. 27631 could be improved by adding a small lug to the casting to prevent the screen from dropping out of place. There are other types of filters which do not require a screen of special shape.

There are a few miscellaneous bolts, nuts, bushings, etc., that, for the sake of uniformity, should be made to fit one of the wrenches on hand.

The stoper-handle nut, to fit the chuck-wrench, needs to be 1¼-in. across flats. The handle nut on the CC 11, 16 V, DT 42, DT 44, and Waugh 71 is the proper size.

Some of the stopers require chuck retaining bolts. The chuck-bolt details on a few of the machines are as follows:

Machine	Size of bolt, inches	Nut	Remarks
Waugh 71	¾ by 5¼	Hexagon	Nuts on both ends.
16V	¾ by 4	Hexagon	
CC 11	¾ by 5½	Hexagon	

It appears as if the same size of bolt, with a square nut, can be used for the safety collar and chuck.

TABLE NO. 14

	Swivel-Nut or Bushing				
	Shape and diameter across flats, inches		Threads per inch	Diameter inches	Fitting to machine from hose, size, inches
DRIFTERS:					
DX 61	Hexagon	1 7/16	14	1 1/2	3/4 Nipple
Turbro	Hexagon	2 1/4	16	2	3/4 Pipe (Same as 71)
18 Leyner	Hexagon	1 3/4	14	1 1/2	1/2 Nipple
150 D	Hexagon	1 13/16	14	1 1/2	3/4 Nipple
548 Leyner	Round	2	12	1 5/8	3/4 Nipple
STOPERS:					
CC 11					3/4 Nipple
71	Hexagon	2 1/4	16	2	3/4 Pipe (Same as Turbro)
Dt 42 and 44	Hexagon	1 7/16	14	1 3/4	3/4 Nipple
PLUGGERS:					
DP 33	Hexagon	1 7/16			3/4 S. Nipple
NRW 93	Hexagon	1 1/2	14	1	3/4 Nipple Lock-nut
DCRW 430	Hexagon		11	1 1/16	Special thread.
Clipper			11		3/4 Nipple

	Air-hose spud			
Make	Hose, Inches	Diameter, Inches	To Nut Threads per inch	Inches across head.
I-R	1, 3/4, 1/2	1 3/16	11 1/2	2
Waugh	3/4	1 1/2	8	1 3/4
Sullivan	1	1 11/16	9	1 7/16
Sullivan	3/4	1 7/32	12	1 7/16

The cradle clamp-bolts on the Waugh Turbro drill are:

Rear clamp-bolt, ⅝ by 6¾ in., hexagon nut on both ends.
Front clamp-bolt, ⅝ by 5¼ in., head on one end.

On the 148 and 248 Leyners the valve-head bolt-nut is hexagon in shape and 1$^{13}/_{16}$ in. across flats. It fits the large end of the chuck-wrench.

Throttle-Valve Handle

No attempt has been made to standardize the details of the throttle-handle. At present, few of the handles are interchangeable. Table No. 7 calls attention to the varying shape of valve-stems.

Water-Valve

The standard make of ⅜-in. brass needle-valve costs materially less than the rock-drill manufacturers' valve. The standard brass valve gives just as satisfactory service as the more expensive product. The threads on the steel valve rust quickly. The valve-stem cap should be 1¼ in. across flats, as it is on most of the valves in use in the Copper Queen mines.

If it were not for pipe-scale getting in the valve-seat, it would be an improvement to have the hose-stems fixed to the valve. This would prevent the miner from disconnecting the water-hose at the valve. The hose-stem made out of ⅜-in. pipe-nippel is more satisfactory than the more expensive stem with the shoulders. The shoulders too readily permit the use of a wrench to break the water connection at the valve instead of at the spud. The "goose-neck" and valve should at all times stay on the hose, and not on the rock-drill.

The most satisfactory form of water-valve handle would be the one-ended lever shape; that is, similar to the shape of the throttle-valve handle. The cross-bar and wheel forms of handle are too easily caught when dragging the hose.

Conclusions

To standardize drilling machines it is essential that the manufacturers adopt the same specifications in making the fittings used on rock-drills. As nearly as possible the spuds, air-swivel nut, back-head cap, back-head plug, oil-plugs, etc., should be interchangeable between the drifters, stopers, and

plugger-drills. Special threads, bolts, and nuts should be avoided except where they are absolutely necessary. As few sizes of bolts, nuts, and bushings should be used as is practical. Not more than two sizes of guide-shells should be standardized. There should be three lengths of feed-screw, and two lengths of standard rods.

It is important that all bolt-nuts, bushings, and spud-heads subject to severe usage should fit the chuck-wrench. The most important fittings to be handled by the large end of the chuck-wrench are the square nuts on the arm, clamp, and swing-bolts. It is also necessary that the large end of the wrench fit the head of the air-swivel nut, air-spud, and valve-head nut.

Among the parts for the small end of the chuck-wrench to take care of, are the water-connection nut, back-head cap, safety-collar nuts, oil-plugs, water-valve cap, and perhaps the side-rod bolt-head, the slide and clamp-nuts on the plugger-cradle.

To handle the smaller nuts about the machine one other two-ended wrench will be required. If ½-in. bolts are necessary to the drill construction, this smaller wrench can be made three-ended. In designing this wrench it must be remembered that one end, probably the ⅜-in bolt end, will have to be so placed as to allow its handling the back-head plug.

To eliminate the monkey-wrench, a box-wrench will be needed to take care of the drill-steel. This wrench can probably be placed between the jaws of one of the regular wrenches.

In this discussion it has been suggested that to reduce the number of size of bolts, nuts, etc., the parts listed below might be made as follows:

Size of bolt, ¾ by 5 in., square nut;
Column cross-bar bolts;
Safety-collar bolts;
Stoper chuck retaining-bolts;
Size of bolt, 1⅛ by 6¼ in., possibly bevel head, special nuts;
Arm-bolts;
Special square nut for the ⅞-in. swing-bolt to be the same distance across flats as arm and clamp-bolts;
Size of bolt, ⅜ by 2 in., square nut;
Throttle handle bolt;
Crank-bolt;
1 in., ¾ in., and ½ in. clamp-bolts;
Size of bolt, ⅝ by 1 in., hexagon nut;
Cradle standard rods; and
Machine side-rods.

On the Ingersoll-Rand cradle, it may be possible to use the same size of bolts for the mounting slide-clamps, cross-head, and feed-screw support.

Having the use of two wrenches, one a chuck-wrench with $1\frac{15}{16}$ and $1\frac{5}{16}$-in. jaw openings, the other a lighter weight double ended $\frac{3}{8}$ and $\frac{5}{8}$-in. bolt-wrench, the sizes of bolts nuts, etc., in Tables 15 and 16 have been suggested.

Drill-Steel

All the drill-steel used in the Copper Queen mines pass through a centrally located surface shop, which is within a few feet of one of the principal shafts. With the exception of the drill-steel used in that division of the mine, it all has to be transferred daily each way by auto-truck between the mines and the sharpening shop. The drill-steel is handled between the shaft-collar and the underground tool-racks by the mine tool nippers.

There are now in use in the Copper Queen mines four different kinds of drill-steel. Among the disadvantages of not having one standard form of drill-steel are:

(1) To permit proper distribution with the various kinds of steel in use, it is necessary that careful sorting and counting be done by both the mine and shop nippers.

(2) The use of several kinds of steel places more labor and responsibility upon the underground tool nippers.

(3) With several kinds of steel in the rack, it is necessary that the drill-runner should be more careful in his selection of the steel for the shift's work. If there were but one kind of steel in use in the mine, the drill-man would have a larger supply from which to choose.

(4) With various kinds of steel to be sharpened, the shop loses more time in frequently having to change dies, dollies, blocks, and formers. The additional supply of tools required means more expense. In the shop it is not only necessary to sort out the various lengths, but the different sizes of steel as well. When different sizes of drill-steel are in use, the lengths of starters, size of bits, and length of change are likely to be different for the various steels.

TABLE NO. 15

Part	Bolt, inches	Nut shape	Nut across flats, inches	Wrench
Air-spud nut		Hexagon or lugged		L chuck.
Air-spud head		Hexagon	1 13/16	L chuck.
Air-swivel nut		Hexagon	1 1/4 or 1 13/16	S or L chuck.
Arm-bolts	1 1/8 by 6 1/4	Square	1 13/16	L chuck, (Bevel-head bolt, extra long nut)
Back-head cap		Hexagon	1 1/4	S chuck
Back-head plug			5/8	3/8
Clamp-bolts	1 1/8 by 6 1/4	Square	1 13/16	L chuck (Bevel head, extra long nut)
Clamp jaw-bolt	5/8 by 3 3/4	Square	1 1/16	5/8
Column cross-bar bars	3/4 by 5	Square	1 1/4	S chuck.
Crank-bolt	3/8 by 2	Square	1 1/16	3/8
Feed lock-nut		Hexagon	1 13/16	L chuck.
Feed-screw support	5/8	Square	1 1/16	5/8
Hose clamp-bolts	3/8 by 2	Square	1 1/16	3/8
Oil-plugs	7/8	Hexagon	1 1/4	S chuck.
Plunger cradle cross-head bolts	5/8 by 3	Square	1 1/16	5/8
Plunger cradle forward clamp-bolt	5/8 by 3	Square	1 1/4	S chuck (special nut)
Plunger cradle rear clamp-bolt	5/8 by 5 or 6	Square	1 1/4	S chuck (special nut)
Plunger cradle slide-bolt	3/4 by 5 or 7 1/2	Square	1 1/4	S chuck.
Plugger-handle bolt	5/8 by 14	Square	1 1/16	5/8
Safety-collar bolt	3/4 by 5	Square	1 1/4	S chuck.

TABLE NO. 15—(Continued)

Side-rods	5/8	Hexagon	1	5/8 (special nut, 1 1/4 bolt-head)
Side-rods	3/8	Hexagon	5/8	3/8 (special nut)
Stoper chuck retaining-bolt	3/4 by 5	Square or Hex.	1 1/4	S chuck.
Stoper handle-nut	3/4	Square or Hex.	1 1/4	S chuck (special shape)
Standard rods	5/8	Square	1 1/16	5/8
Swing-nut	7/8	Square	1 13/16	L chuck (special nut)
Throttle-bolt	3/8 by 2		1 1/16	3/8
Turbine box-bolts	3/8			
Turbine cradle clamps	5/8	Hexagon	1 1/16	5/8
Valve-chest bolts	5/8	Hexagon	1 1/16	5/8
Valve-chest bolts	3/8	Hexagon	1 1/16	3/8
Valve-head bushing		Hexagon	1 13/16	L chuck.
Needle-valve bushing		Hexagon		3/8 or 5/8
Water-spud		Round		
Water-spud nut		Hexagon	1 1/4	S chuck.
Water valve cap		Hexagon	1 1/4	S chuck.

TABLE NO. 16

Number of fittings or machines examined	Part	Different forms now in use	Standardized to
6	Air-spud		1
6	Air-spud nut	4	1
13	Air-swivel nut	4	2
7	Arm-bolt	8	Same as clamp-bolt
1	Arm-bolt nut		Same as clamp-nut.
9	Back-head cap		1
9	Back-head plug	7	1
9	B. H. gland rubber	4	1
1	Clamp-bolts	5	
1	Clamp-nuts	2	1 Same as arm-bolt
1	Clamp jaw-bolt	1	1
1	Column cross-bar bolts		1
9	Crank-bolt	3	Same as collar-bolt
9	Cross-head	5	Same as throttle-bolt
9	Feed-screw	6	1
8	Feed lock-nut	6	3
8	Feed-screw support	3	1
4	Handle bolts, pluggers	5	1
6	Hose clamp-bolts	4	1
11	Oil-plugs	1	1
1	Plugger cradle cross-head bolts	1	1
3	Plugger cradle forward clamp-bolt	3	1 (Possibly same as cross-head bolts)
3	Plugger cradle rear clamp-bolts	3	1
1	Plugger cradle slide-bolt	1	1
1	Safety-collar bolt	1	1

TABLE NO. 16—(Continued)

9	Shell casting	6	2
15	Side-rods	12	3 or 4
3	Stoper chuck-retaining bolt	2	1
5	Stoper handle-nut	1	1
8	Standard rods	5	2
1	Swing-bolt	1	1
1	Swing-nut	1	1 Same across flat as arm or clamp
8	Throttle handle-bolt	6	1
2	Trubine-chest bolts	2	1 (diameter only)
2	Turbine cradle-clamps	2	2
10	Valve-chest bolts	3	2 (diameter only)
1	Valve-head bushings	1	1
1	Water-spud	2	2 (head only)
6	Water-spud nut	6	1

(5) As the number of any one class of rock-drills in use in the mine will vary from time to time, there will often be an excess or shortage of one or more kinds of drill-steel.

Steel Used in the Copper Queen Mines

The four kinds of steel now in use in the Copper Queen mines are as follows:

(a) For use in drifting machines:
1¼-in. round hollow steel with the regular Leyner shanks.

(b) For use in wet stopers:
⅞-in. hexagon hollow steel with a plain shank.

(c) For use in dry stoping:
1-in. cruciform solid steel with a plain shank.

(d) For use in plugger machines:
⅞-in. hexagon hollow steel with the regular Jack-hamer collar-shank.

Table No. 17, page 767 lists the length of change, length of starter-drill, diameter of starter-bit, weight of the steel bar per foot, and the width of the wings of the bit for the various kinds of drill-steel now in use in the Copper Queen mines.

The above figures show the frequency with which the fittings on the mechanical sharpener must be changed. At present, about 1250 pieces of steel pass through the sharpening shop per 24 hours. Of this total, 500 are 1¼-in. Leyner steel.

Throughout the Copper Queen mines the ground is very changeable; there is much ground that is either "ravelly" or very soft. Either of these conditions would prohibit the use of plain shanked steel in the drifter and plugger machines. In general, lug-shanked steel would be an improvement over the present form of stoper steel.

During the last few months [to Nov., 1920], tests were made in one division of the mines with the idea of replacing the four kinds of drill-steel now in use by 1-inch round hollow steel with lugged shanks. To give the necessary strength, the lug on the 1-in. steel is 1 in. long, while the lug on the 1¼-in. shank is only ¾ in. long. If the 1-inch round steel were adopted, the Leyner man would have to handle only steel that

TABLE NO. 17

Shape and size of steel bar, inches	Length of change, inches	Length of starter-feet	Diameter of starter-bit, inches	Weight of bar per foot, lbs.	Width of bit-wing, inches — Starter	2nd	3rd	4th	5th
1¼ round hollow..........	18	3	2	3.98	⅞	⅞	⅞	¾	¾
⅞ Hexagon hollow......	15	2½	1 11/16	2.08	1 1/16	1 1/16	1 1/15	1 1/16	1 1/16
1 cruciform, solid......	15	3	1 11/16	2.23	1 1/16	1 1/16	1 1/16	1 1/16	1 1/16

weighs about 2½ lb. per foot, while the 1¼-in. steel now in use weighs nearly 4 lb. per foot. On the other hand, the stoper and plugger-steel weights would be slightly increased; but the difference would be of no consequence, as a 7½-ft (5th size) 1-in. drill-steel is not difficult to handle.

TABLE NO. 18

1 In. Round Hollow

Drill	Length ft.-in.	Weight, pounds
Starter	2–6	6.2
2nd	3–9	9.3
3rd	5–0	12.4
4th	6–3	15.5
5th	7–6	18.6
Total		62.0

1¼ In. Round Hollow

Drill	Length ft.-in.	Weight, Pounds
Starter	3–0	11.9
2nd	4–6	17.9
3rd	6–0	23.9
4th	7–6	29.8
Total		83.5

⅞ In. Hexagon Hollow

Drill	Length ft.-in.	Weight, Pounds
Starter	2–6	5.2
2nd	3–9	7.8
3rd	5—0	10.4
4th	6–3	13.1
5th	7–6	15.6
Total		52.1

1 In. Crucifrom Solid

Drill	Length ft.-in.	Weight, Pounds
Starter	3–0	6.7
2nd	4–3	9.5
3rd	5–6	12.3
4th	6–9	15.1
Total		43.6

Table No. 18 shows that with the adoption of 1-inch round steel there would probably not be a saving in the weight of steel required to supply the mines. The 1-inch round steel would be more easily bent than the 1¼-in. steel, but would be harder to bend than the ⅞-in. hexagon steel.

That the round steel with the lugged shank, rather than the plain shank hexagon steel, has been tried is due to the character of the ground in the Copper Queen mines, and that the round section is naturally the stronger one. The plain shank-steel offers the advantage that there is no shank to form, other than grinding and tempering one end of the bar. If it were not for the form of steel retainer required, perhaps the collared shank would give better results than the Leyner shank, as the ring is the first stage of the forging when making the lug. The collared shank-steel could be made to be used with both anvil-block and tappetless machines.

So far, 1-inch round steel has proved satisfactory with all but the "wiggletails.'

Shank breakage at either end of the lug is the difficulty encountered with the stopers. The breakage with some of the hand-rotated machines has gone as high as 20%, but with the mechanically-rotated stopers has not exceeded 3%. Though ⅞ hexagon and 1-in. cruciform steel have been used successfully in the stoper-drills for years, this drill-steel has had only plain shanks. The weakness in the 1-inch round steel seems to develop when upsetting the bar to form the lugs of the Leyner shank.

Careful Heat Treatment

It is thought that this difficulty can be overcome by more careful heat treatment in the shop; not that the 1-inch steel is being treated more carelessly than the 1¼-in. Leyner steel, but that the lighter steel should be given more special attention to make it stand the strain. The shank breakage in the regular run of drill-steel does not go above 0.7%.

The actual practice in the Copper Queen shop is to temper only the striking end of the shank. Some of the entire shanks of the experimental steel have been tempered in fish oil, and these have given better results. The breakage increases with the continued use of the drill-steel.

In much of the 1-inch drill-steel the hole through the bar is distorted in regard to both shape and position. Not in all cases is the distortion due to forging in the sharpening shop, as an examination of many bars has shown this condition not limited to the shank. Any alteration from the round hole means an unnecessary weakness. The position and shape of the hole in hollow drill-steel is an important matter worthy of careful consideration.

Another weakness in the use of lug-shanked steel for stopers is that the Leyner form of chuck does not offer as much support to the drill-steel as does the plain shank-chuck.

Throughout these tests, an air pressure of about 85 lb. per sq. in. was delivered to the stopers. If the air pressure had been reduced 5 or 10 lb., the shank breakage would not have been as high.

Drilling Speed

When using the 1-inch steel in the large drifting machines there did not appear to be any material increase in drilling

speed above the results obtained with the 1¼-in. steel. The bit on the 1-inch round steel is 1¼-in. less in diameter than the corresponding bit in the 1¼-in. steel. In some cases, the 1¼-in. steel out-drills the smaller steel. From these results, it looks as if the large drifting machines were too powerful for the 1-inch experimental steel. Undoubtedly the same inches cut per minute could be obtained with a smaller rock-drill and 1-inch steel. If it is reduced, and though the first cost would be higher, the upkeep expense would be reduced. Most manufacturers make their rock-drills to run most efficiently at 70 lb. of air.

An outline of the progress followed in making the Leyner shank is as follows:

(1) Heat to about 1800° F.
(2) Countersink hole in head of drill and forge.
(3) Re-heat to 1800° F. and upset for ring.
(4) Re-heat to 1800° F.
(5) Punch, drive in pin, and form lug complete.
(6) Let cool in air on shop floor.
(7) Heat shank for 1½ inches from striking end to 1400 to 1500° F., and draw last ½ inch to blue color.

To form the collared shank:

(1) Grind striking end of shank.
(2) Heat to 1800° F., put on collar by upsetting.
(3) Re-heat to 1800° F., countersink, put in pin and forge shank to proper size.
(4) Let cool on shop floor.
(5) Heat shank for 1½ inches from striking end to 1400 to 1500° F., and draw end of shank to blue color.

General Conclusions

From the foregoing it is evident that great economy in both the manufacture and use of drilling machines can be obtained by careful study of the fittings used in the routine operation of air-drills and the adoption of standard specifications for same.

The suggestions made are not offered in any spirit of criticism, but in the belief that joint study of the question by both drill manufacturers and operators cannot fail to result in mutual benefits.

With this in mind, I offer the further suggestion that a joint committee be appointed to consider the question and submit

recommendations to both parties for the adoption of standard specifications.

Furthermore, I do not consider it wise to attempt to standardize the types of drilling machines themselves to be used in mining operations; to do so would seriously handicap the efforts of the designers to improve them. Their past record in the development of drilling machines is sufficient evidence of the value of unrestricted competition in design.

I am in favor of the lightest type of machine in the various classes of work that will stand up with a reasonable cost of maintenance.

In the matter of drill-steel, I believe that material economies will result from the adoption by individual operators of one section of steel and one form of shank for all types of machines used by them, with due regard for the particular conditions encountered in their work.

RELATION OF STANDARDIZATION TO MINE MANAGEMENT

By CHAS. A. MITKE, Chairman of General Committee Standardization, Metal Mines Section, American Mining Congress

It has been well said that "great economies in any business of production result from careful and thoughtful attention to details, and mining is no exception to this rule. On the contrary, successful mining is one of the greatest embodiments of the principle. Just as the difference between the careful manager and the careless one is apt to be the difference between profit and loss, so the difference between standardization and non-standardization is very frequently the difference between good and bad management."

Labor Is 50% of Costs In Mining

Estimates show that in metal mining over 50% of the total cost of production is chargeable to labor; therefore, the proper directing and systematizing of the activities of labor, to eliminate the waste of human efforts, is an important factor in the standardization of mining operations.

In mines where only a few men are employed, and a small tonnage produced, the entire supervision can be accurately directed by one general foreman, and the question of standardization does not enter largely into the daily work. However, where great tonnages must be produced at a low cost, and where the entire supervision of all details by one man is utterly out of the question, but of necessity rests in the hands of a large organization, then the standardization of all operations not only becomes very desirable but absolutely essential.

The need for a scientific investigation of mining practices or mining methods, with a view to alleviating present conditions—as regards high production costs—which have been brought about largely through high cost of supplies, increased advances in wages, and loss of efficiency due to the employment of unskilled or raw labor, has made itself felt throughout the entire mining industry, not only in the United States, but also in Europe.

Wage Increase and Grade of Ore Decrease

In one large center in this country, wages, which in 1914 ran from $3.75 to $4.25, now range from $4.65 to $5.40 per 8-hour shift. Taxes, supplies, freight rates, etc., are also considerably higher than they were several years ago, with no immediate prospect of reduction. Moreover, inevitably, the grade of the ore in many properties will decrease as time passes. This necessitates the mining of much larger tonnages in order to maintain the ultimate output at the same level.

Therefore, the only remaining alternative for the mine management is to make the workers so efficient as to warrant the continuance of operations under existing conditions. This can only be accomplished in the following manner:

(1) Americanization, which merely begins with the teaching of the English language.

(2) Education of employes (from heads of departments right through the entire organization down to miners and shovelers) in the most efficient method of performing the daily task.

(3 By establishing a standard program for all operations, in order that human efforts may be utilized to the greatest advantage.

(4) By furnishing the men with standard equipment, in order to facilitate routine work and make their efforts more productive. And

(5) In order to encourage the miner to put forth his best efforts in attaining maximum production, an incentive, over and above day's pay, should be offered by the management.

Another most important factor in developing a scientific organization is the "setting of standards for work done." A very vital question is, what constitutes a day's work? What was assumed to be a day's work five years ago cannot be adopted as standard today. The wage system, whether contract or bonus, must be based on actual knowledge and justice. Nothing is more discouraging to a workman, or productive of more ill-feeling and discontent, than to have the standard bonus or contract rate cut because he has performed his work

exceptionally well and made a greater footage than the rating engineer ever anticipated could be made under the schedule. Cutting the bonus after it is once established is responsible for the great feeling of distrust which many men show towards working under any system other than day's pay.

Time and Skill Needed In Standardizing At Mines

In order to achieve a universal success, time and thought must be devoted to an intensive study of the details of mining. Each operation must be divided into its component parts, and standardization applied to each unit. Experimentation is also a necessary part of the program, and should be encouraged and fostered by the management. The workers must be trained to perform their tasks efficiently and intelligently. Labor-saving devices and equipment should be substituted for hand labor wherever possible. Unskilled labor should be supplanted as far as possible by mechanical means. This should not be interpreted as meaning a loss of employment to many who are now engaged in this class of work. There is plenty of work for all, and the performance of work by machinery, requiring little or no intelligence, will release thousands of men who can be trained for better paying jobs.

Until recently, the systematization of metal-mining operations was considered impracticable, particularly those operations carried on underground, from which natural circumstances have, to a large extent, excluded the light of publicity. The reserves of many of the larger mines have also been so rich and extensive that economy has not played as important a part, perhaps, as it should. The ever-present possibility of "sweetening the ore," or, in other words, bringing the daily output up to expectations by the addition of higher grade—kept in reserve for such purpose—has often tided over situations which, otherwise, might possibly have disclosed unsystematized methods and careless supervision on the part of underground bosses, to whom quantity plus quality at the moment meant everything, regardless of the disastrous effect their methods might have upon the future life of the mine.

What Happens Underground

Moreover, underground operations are to a large extent shrouded in obscurity, and the intimate details are known only

to a few, whose business it is to make daily visits to the working places. The larger number of the employes are frequently ignorant men, whose main interest in their work is to get out the number of cars required by the boss, and to whom ore and waste are of very little interest, except as they add to the required tonnage.

The needs of the manufacturing industry, and the keen comuetition encountered, have developed a host of experts, and production engineers, who have delved into the intricacies of the different branches and brought to light innumerable operations which lend themselves well to the adoption of standard methods.

Unfortunately, in the mining industry, no sweeping changes can be effected, which, in the course of a short period of time, might be expected to revolutionize the industry at large, and produce the same gratifying results as have been obtained in industrial plants. This fact, in itself, has acted as a deterrent in the systematization of mining operations, and while, in individual cases, alert, wide-awake operators have made considerable progress along these lines, the industry as a whole does not reflect the same systematization of operations that may be found in manufacturing plants.

Mining Practice Less Studied Than Metallurgy

It is generally conceded that mining is a profession that should require a highly specialized training, but as a rule sufficient emphasis is not placed upon the practical application of such technical knowledge. Too much dependency is placed upon practical experience alone, and too little on scientific principles. Far be it from the writer to discredit practical knowledge. The mining industry in the past owes much to its practical men, but what it now requires is practical knowledge superimposed on a scientific basis, or, in other words, the attention of men who have added years of practical experience to their specialized or scientific training.

The metallurgical branch of the profession has been the subject of much thought and study, and considerable research is continually being carried on in this branch of the profession. Contributions have also been made to the mining branch, but in the main these have consisted rather of descriptions of prac-

tices already in use in certain localities, than in the nature of original research work.

An X-ray analysis of mining operations as a whole, frequently discloses out-of-date methods which would not for an instant be tolerated in surface plants. What large factory owner, for instance, would permit one of his operators to spend two-thirds of his day away from his machine, hunting parts, supplies, lubricating oils, etc.? There, the output is based on machine production for each man, and the amount he can turn out is calculated to a nicety, and it is the imperative duty of the shop foreman to see that everything required is present and the machine in good order before the man starts to work.

Comparison of Work of Miners and Factory Workers

It is, however, a common occurrence underground for a first-class machine-drill operator to spend a large portion of his time walking through drifts and tunnels in search of sharp steel, or the right kind of steel to fit his machine, repair parts, oil-cans, or returning defective machines to the tool-house and carrying new ones to take their place.

In the factory, fatigue studies have been made, covering every action from the steps taken in performing certain duties, to the movements made by each hand of the individual worker in handling manufactured parts. In mining, however, it has come to be an unwritten law that so long as the machine-man drills a round of holes—special allowance being made for unusually hard ground—he has performed his daily task, regardless of the fact that—like Taylor's handler of pig-iron—providing his operations are studied and systematized, he might be made to double his performance with comparatively little additional effort to himself. This has been demonstrated in a number of instances; yet, as a whole, it still continues to be the general practice to consider one round of holes a day's work. The responsibility for this lies largely with the mine management. Formerly, in a great many instances, atmospheric conditions of working places were such that men could not work consistently during an 8-hour shift; and in many cases it grew to be the practice for men to work a certain period and then seek a better atmosphere in the mine, where they cooled off and rested for an equal period of time. Also,

in years past, the ventilation of mines was so bad that no blasting could be allowed during the shift, and consequently after the miner drilled his round of holes he would merely while away the remainder of the shift until quitting time, and fire the shots when leaving the mine. With the improvement that has already been made in metal-mine ventilation, it has been proved in exceptionally well-ventilated mines that shots can be fired at any time during the shift without inconveniencing the men. As a matter of fact, in one large mine, which is well ventilated, there is a shot fired every minute during the shift, with little or no resulting delay to the underground force. Now that every effort is being made to attain underground working atmospheres as nearly as possible approximating those on surface, this custom of considering one round of holes a shift's work—regardless of its depth—which is really nothing more than habit, must be overcome if mining operations are to be placed on an equal footing with those on surface.

Other Departments at Mines Capable of Improvement

This is but one example of the lack of systematization in mining operations. Much benefit could also be obtained from careful study of explosives, their use and handling; the correct placing of machine-drill holes; handling of timber, both underground and on surface, where much unnecessary labor is involved in handling and re-handling each piece as it comes from the cars, the writer having observed as many as 12 men employed at the same time in handling one stick of timber.

The distribution and care of underground supplies is another subject which would react most favorably to research.

The standardization of equipment and supplies is closely linked with the systematization of operations, and of necessity the one must be studied along with the other.

Too Many Different Drills

The industry at the present time is burdened with a multiplicity of machine-drills of varying types, sizes and weights, the difference in weight in some instances not being more than 1 to 2 lb. The production of these machines follows each other with such rapidity that in an effort to stock up with the best equipment available on the market many machines in

good condition must be scrapped, and as parts are not interchangeable, a considerable investment in such supplies must continually be charged off to profit and loss. The development of these machines is, of course, carried on by the manufacturer to meet the needs of the industry; but, unfortunately, these needs are often the individual ideas of various operators rather than the combined views of the majority. What may appeal to one does not appeal to the other, and consequently the necessity for purchasing and trying out this variety of types becomes an ever-increasing burden on the operator.

During the past seven years the necessity for a drifting machine, permitting the use of water and air through machine and steel, became so evident to practically every purchaser of rock-drills that, as a result, the manufacturers evolved the water-Leyner. The self-rotating water-stoper, which is now nearing perfection, is also the result of the combined needs of the mining industry. Many other improvements in drilling machines are possible, providing some research work is devoted to the subject of finding out just what specifications would meet the needs of the majority for the different types of machines, such as jackhamers, drifters, and stopers.

The chucks on all machines must become standard, so as to permit the inter-change of different makes of steel. The lack in efficiency and the loss of time incurred at present through miners supplying themselves with steel which does not fit the machine they are using at the time, is such that this change has become an absolute necessity.

Sizes of Drill-Steel

The size and types of steel should also receive attention. There are individual cases, where companies have standardized on the ¼ hollow octagon for all stoping and raising, and find this type of steel satisfactory for all their needs. Other companies are achieving excellent results with the 1-inch hollow round. Research would bring to light many facts that might tend to prove that one of the other of these two was the more satisfactory. The same is true of hose fittings, and various parts and supplies for machines.

Underground power shovels to supplant manual labor in shoveling should receive attention, in order to avoid the creation of the multiplicity of slightly varying types, similar to that at present existing among rock-drills. It is inevitable that mechanical equipment must supersede hand labor underground to a large extent, if we are to overcome the scarcity of labor, both skilled and unskilled, and increase the tonnage per man shift, at the same time maintaining the normal grade of the ore, which is the principal means of combating the present high cost of production. Shoveling is one of the most important items in underground operations.

Underground Transportation and Ventilation

Care and attention might profitably be devoted to underground transportation, the grade of tracks, weight of rail, etc. Also, the possibility of standardizing on a few sizes and types of mine cars, rather than on the unusually large number now on the market, and the various methods of haulage, compressed air, electric, and steam.

The ventilation of metal mines is a subject of the utmost importance. Without good air no man can live, much less work, and upon the condition of the working place depends very largely the efficiency of the worker. Much of the trouble resulting from bad air in metal mines at the present day comes from the deficiency of ventilation in dead ends in drifts and stopes. The ventilation of such working places can greatly be improved by resorting to systematized methods in regard to the use of certain types of small blowers and ventilating pipe, care and attention being devoted to the manner in which these are located and operated. The prevention of dust in mines necessitating frequent blasting during the shift is another means of raising the efficiency of the miners. In the past, bad air, rock dust, and heated atmospheres were looked upon as necessary evils which could not be overcome, and the man who could not put up with a certain amount of such discomfort was rather contemptuously referred to as one who "could not stand the gaff." Today, such conditions are unnecessary, and the adoption and use of standard equipment and standard methods will provide the men with a working atmosphere in which they can put forth their best efforts without discomfort to themselves. The systematic testing of mine

air and the adoption of a standard atmosphere is one of the pressing needs of the industry.

Fires in Mines

Fire-fighting equipment and systematized rules for combating outbreaks in the mine are also of the utmost importance, as the profit and loss accounts of many companies show large sums charged off to disasters of this kind, which might possibly have been averted through the keeping in stock of a standard line of fire-fighting apparatus.

There are many other subjects in the mining industry to which standardization can be applied, such for instance as cost accounting. Frequent discrepancies in the manner of keeping costs are encountered, even in properties owned by the same company. For instance, one mine will charge off the work of preparing an orebody for stoping to development work or to a separate fund which has been laid aside for such purpose. Their production costs may then appear quite low, for the reason that this large sum which should necessarily be added to the stoping cost, as it all goes against the ultimate profits, is omitted, while other companies include development costs, but exclude overhead and supervision, and so forth.

Ore Reserves and Taxation

The estimation of ore reserves is another matter for research; equitable taxation, and many other items, all come under the head of subjects to which standardization might be applied.

An objection frequently raised against standardization is that it retards progress, and that having once decided on a standard, there is no possibility of change and old standards must be adhered to even though newer methods have been developed which have outclassed the old. In this connection it may be well to quote from an authority* on this subject, who well describes the functions of a standard, in the following words:

"A standard is simply a carefully thought-out method of performing a function, or carefully drawn specifications covering an implement, or some article of stores, or of products. The

Morris L. Cooke. Bull. No. 5, Carnegie Foundation Series.

idea of perfection is not involved in Standardization. The standard method of doing anything is simply the best method that can be devised at the time the standard is drawn. * * * Improvements in standards are wanted and adopted whenever and wherever they are found. There is absolutely nothing in standardization to preclude innovation. But to protect standards from changes which are not in the direction of improvements, certain safeguards are erected. These safeguards protect standards from change for the sake of change. All that is demanded * * * is that a proposed change in a standard must be scrutinized as carefully as the standard was scrutinized prior to its adoption. Standards adopted and protected in this way produce the best that is known at any one time. Standardization practiced in this way is a constant invitation to experimentation and improvement."

Standardization of Great Importance to Mines

The standardization of mine equipment and mine operations in the various branches are of vital interest to the mine manager who is responsible for the ultimate cost of the product. In order to work out these problems, to accumulate the correct data upon which to base conclusions, and finally to introduce standard methods, it is absolutely necessary that the mine manager effect this change through the medium of his organization, composed of heads of departments, foremen, bosses, and engineers. Their intelligent co-operation is therefore an essential part of the program. These are the men who represent the company, or mine management, and interpret the policies and desires of the company to the great mass of employes. They are also intimately acquainted and associated with the multiplicity of operations which, combined, form the activities of the mine. If their interest and enthusiasm is directed towards a study and systematization of the details which form the various groups of operations, then through the standardization of many small tasks, which by themselves may not appear important, under the careful supervision of the mine management, larger economies will result, which, in turn, will ultimately have the desired effect of reducing production costs.

STANDARDIZATION WORK OF THE UNITED STATES BUREAU OF MINES

By F. G. COTTRELL

In attempting to standardize mine equipment, the current best practice can be crystallized into the form of a code or set of rules and regulations; but in any such attempt there are always items about which there is a lack of proper information; so that there is doubt whether such items should be crystallized into a code or passed over with as little attention as possible. There are frequently matters that yield to laboratory investigation, facilities for which are rarely available to the mine operator. These rather difficult points are rarely comprehensive enough to form the basis for a code covering any considerable portion of a field, and yet they may themselves form a standard of good practice. This can be illustrated by the Bureau of Mines' permissible explosives or the miners' cap-lamps, or possibly the Bureau's rules for installing and using electrical equipment in bituminous coal mines.

Besides the results of laboratory work and special investigation, there is also that type of work which is the result of conferences of men of prominent standing in their profession and who are regarded as authorities in their own field, and who write their opinion of current best practice in the form of rules and regulations. This type of work is illustrated by the 'Rules and Regulations for Metal Mines,' compiled by mining engineers of standing, and 'Proposed Regulations for the Drilling of Gas and Oil Wells through Coal Beds.'

Approval System As Basis for Standards

While not directed toward the production of standards for mining equipment, still the Bureau's approval system furnishes material that may well form the basis of standards for certain equipment. It is frequently the case that in the commercial development of a really good idea, the early productions are foredoomed to failure because of lack of information and a proper ideal in designing the apparatus. In safety matters this is of particular interest to the Bureau of Mines. In the development of electric machinery for use in gaseous mines,

questions arise as to the proper protection of the device so that sparks may not ignite gas, if perchance the apparatus is in a gaseous atmosphere. Some kinds of sparks readily ignite gas, while others will not. Certain kinds of protective devices will prevent ignition from etxending into the surrounding space. If the apparatus is designed in a manner ignoring these facts, the business can develop only through dangerous and disastrous experience and loss of life. After an investigation, the Bureau draws a minimum specification for such devices, and allows those companies which meet this minimum specification to mark their devices as approved by the Bureau of Mines. This minimum specification allows ample room for individual initiative and development beyond the line of necessary safety. This work forms the basis of standardization for such devices in order that they shall be safe in gaseous mines.

With these illustrations of the purpose of the Bureau, a catalogue of its publications along these lines is sufficient to indicate the field already entered by the Department. For this purpose of special investigation, the Bureau has a large laboratory at Pittsburgh and the facilities afforded by eleven other stations in various parts of the country.

The Bureau attempts to crack the hard nuts in the several fields of safe equipment as rapidly as its funds allow, and it is hoped that the future will afford increased facilities for work of this kind.

Publications Available

A list of the Bureau's publications on this subject follows:

Schedule 1.—'Conditions and Requirements Under which Explosives are Tested.'

Schedule 2A.—'Procedure for Establishing a List of Permissible Explosion-Proof Electric Motors for Mines.'

Schedule 6A.—'Procedure for Establishing a List of Permissible Portable Electric Mine Lamps.'

Schedule 7.—'Procedure for Establishing a List of Permissible Miners' Safety Lamps.'

Schedule 12.—'Procedure for Establishing a List of Permissible Single-Shot Blasting Units.'

Schedule 13.—'Procedure for Establishing a List of Permissible Self-Contained Mine-Rescue Breathing Apparatus.'

Schedule 14.—'Procedure for Establishing a List of Permissible Gas Masks.'

Schedule 15.—'Procedure for Establishing a List of Permissible Storage-Battery Locomotives for Use in Gaseous Mines.'

Schedule 16.—'Procedure for Establishing a List of Permissible Multiple-Shot Blasting Machines.'

Technical Paper 22.—'Electrical Symbols for Mine Maps.'

Technical Paper 53.—'Proposed Regulations for the Drilling of Gas and Oil Wells with Comments thereon.'

Technical Paper 79.—'Electric Lights for Use about Oil and Gas Wells.'

Technical Paper 138.—'Suggested Safety Rules for Installing and Using Electrical Equipment in Bituminous Coal Mines.'

Technical Paper 214.—'Motor Gasoline Properties, Laboratory Methods of Testing, and Practical Specifications.'

Bulletin 49.—'Smoke Abatement and City Smoke Ordinances.'

Bulletin 75.—'Rules and Regulations for Metal Mines.'

Bulletin 116.—'Methods of Sampling Delivered Coal.'

'Advanced First-Aid Instructions for Miners.'

'Rescue and Recovery Operations in Mines after Fires and Explosions.'

The last two are pocket-books issued in 1917 and 1916, respectively.

NATIONAL AND INTERNATIONAL STANDARDIZATION

By P. G. AGNEW, Secretary American Engineering Standards Committee

During or since the war, national engineering standardizing bodies have been organized in Austria, Belgium, Canada, France, Germany, Holland, Italy, Sweden, Switzerland, and the United States, and one is in process of formation in Japan. All of these are similar in form of organization and method of operation to the British Engineering Standards Association, which, organized in 1902, has been a most significant factor in the development of British industry.

Our own society — the American Engineering Standards Committee—was started in October, 1918, and has been actively at work for about a year. At first it consisted of representatives of the American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, and American Society for Testing Materials. Upon invitation, three Government departments—War, Navy, and Commerce—joined in the movement, and appointed representatives; and later, provision was made for representation upon the main Committee of other bodies of national scope interested in standardization. At the time the Committee was organized there were more than 100 American societies actively engaged in standardization work; but there were no systematic, unified methods of co-operation, and there had been a widespread recognition of the need of some central agency for the purpose.

The functions of the Committee are: to unify methods of arriving at engineering standards; to secure co-operation between various interested organizations, in order to prevent duplication of work and promulgation of conflicting standards; to act as an authoritative channel of co-operation in international engineering standardization; to promote in foreign countries the knowledge of recognized American standards; to collect and classify data on standards; and to act as a bureau of information regarding standardization.

Scope of the Work

The scope of the work which is being carried out under the auspices and rules of procedure of the Committee is very broad. The following types of work are found among the standardization projects which are now under way:

1. Definitions of technical terms used in engineering work, specifications, and contracts.
2. Specifications for materials.
3. Methods of tests, especially acceptance tests for materials and apparatus.
4. Dimensional standardization to secure interchangeability of supplies—for example, screws, nuts, and bolts.
5. Dimensional standardization to secure the inter-working of parts, and of inter-related apparatus, made or assembled by different manufacturers, such as shafts, pulleys, etc.
6. Safety codes, to secure uniformity in requirements for safety in apparatus and equipment, and in industrial processes.
7. The limitation of the number of types, sizes and grades of manufactured products—an exceedingly important and far-reaching subject.

Specific Examples

It may be well to mention two or three specific projects:

The British Engineering Standards Association suggested Anglo-American agreement on a standard series of cross-sectional shapes for structural steel. A committee was organized on which are representatives of organizations interested in the question. Among them are the Association of American Steel Manufacturers, American Society of Civil Engineers, Society of Naval Architects and Marine Engineers, American Bureau of Shipping, U. S. Navy, and the Railway Car Manufacturers' Association. Considerable progress has been made, and a representative of the committee was abroad during the early summer to confer with the British.

Another example arises also from an international proposal, this time from Belgium, that there be international standardization for the non-ferrous metals. They outlined in detail what they thought should be done on the question of zinc—the methods of sampling zinc ore, methods of analysis, allowances for moisture content, etc. A committee is being organized for the work on zinc, under the leadership—technically called sponsorship—of the American Zinc Institute and the American Society for Testing Materials. On this committee all the societies that are concerned in the subject will be represented.

Passenger and freight elevators for buildings are built to a large extent to special order. On account of lack of recognized standards, adequate provision is not made in the architect's plans, and steel work is often up before fundamental decisions on elevators are made, and more or less confused and wasteful conditions result. At the joint request of the Elevator Manufacturers' Association and the American Institute of Architects, a conference was called. There were 14 interested organizations that were represented. The action taken was enthusiastic and unanimous that a standardization of elevators, based on fundamental considerations, should be undertaken. Arrangements are being made for a thoroughly representative sectional committee to carry out the detailed technical work.

Another illustration, which is typically American, is the matter of safety codes. There have been in the past at least 100 organizations formulating safety-codes. Nearly all of the 48 States have bodies that have the authority to promulgate safety-codes. At a conference in Washington in January, 1920, where more than 100 organizations were represented, it was unanimously voted that a comprehensive program of safety-codes should be undertaken, and that it should be handled under the auspices and rules of procedure of the American Engineering Standards Committee, in order that there be proper co-ordination, elimination of overlap, etc. Active work is now in progress on about 30 such codes. State commissions, which are the bodies responsible for the legal adoption and enforcement of safety-codes, associations of insurance companies, national engineering societies, manufacturers' and industrial associations, labor and civic organiza-

tions, and technical bureaus of the Federal Government are all heartily co-operating in the work. The committees responsible for the formulation of each of the codes are made up of representatives of such of these bodies as are interested in the particular code in question.

Economic and Industrial Significance

If standardization is carried out on a sound engineering basis:

1. It enables buyer and seller to speak the same language, and makes it possible to compel competitive sellers to do likewise.
2. In thus putting tenders on an easily comparable basis, it promotes fairness in competition, both in domestic and in foreign trade.
3. It lowers unit-costs to the public, by making mass production possible, as has been so strikingly shown in the unification of incandescent lamps and automobiles.
4. By simplifying the carrying of stocks it makes deliveries quicker and prices lower.
5. It decreases litigation and other factors tending to disorganize industry, the burden of which ultimately falls upon the public.
6. It eliminates indecision both in production and utilization—a prolific cause of inefficiency and waste.
7. By focusing on essentials, it decreases selling expense, one of the serious problems of our economic system.
8. By concentrating on fewer lines, it enables more thought and energy to be put into designs, so that they will be more efficient and economical.
9. It stimulates research, to which it is closely allied.
10. It is one of the principal means of getting the results of research and development into actual use in the industries.
11. It helps to eliminate practices that are merely the result of accidental or tradition, which impede development.

12. By concentration on essentials, and the consequent suppression of confusing elements intended merely for sales effect, it helps to base competition squarely upon efficiency in production and distribution and upon intrinsic merit of product.

A stock argument often used against standardization is the claim that it results in crystallization and the throttling of development. Quite the contrary is true if the work is carried out on a sound basis. Crystallization, when it occurs, results from mental attitude, and not from sound engineering standardization. As just stated, standardization in itself is a powerful incentive to research, and is one of the chief means of getting the results of research actually utilized. In attempting to arrive at standards agreement is frequently prevented by a lack of facts, and this leads to the getting of those facts.

Benefits of Research

Dr. W. R. Whitney, the director of one of our great industrial research laboratories, has said that the benefits of research and development work to the public are far greater than to the manufacturer; that while a series of investigations may benefit the manufacturer to the extent of millions, the ultimate benefit to the public will be in hundreds of millions. A striking example that Dr. Whitney had in mind was the incandescent electric lamp. It is doubtful if there is another article in any of our industries that represents more research work either in quantity or in quality. The benefits that have accrued to the manufacturer and to the public could not have been realized had the research work not been supplemented by thorough-going standardization.

Organization and Methods

The American Engineering Standards Committee itself, usually referred to as the Main Committee, is composed at present of 47 members, representing 17 member-bodies, which are as follows:

American Electric Railway Association.
American Institute of Electrical Engineers.
American Institute of Mining and Metallurgical Engineers.

American Society of Civil Engineers.
American Society of Mechanical Engineers.
American Society for Testing Materials.
Electrical Manufacturers' Council—
  Associated Manufacturers of Electrical Supplies,
  Electric Power Club,
  Electrical Manufacturers' Club.
Fire Protection Group—
  Asociated Factory Mutual Fire Insurance Companies,
  National Board of Fire Underwriters,
  National Fire Protection Association,
  Underwriters' Laboratories.
Gas Group—
  American Gas Association,
  Compressed Gas Manufacturers' Association,
  International Acetylene Association.
  National Electric Light Association.
National Safety Council.
Society of Automotive Engineers.
U. S. Department of Agriculture.
U. S. Department of Commerce.
U. S. Department of the Interior.
U. S. Navy Department.
U. S. War Department.

The Committee does not duplicate the work of other organizations. On the contrary, in acting as a clearing-house for standardization, it eliminates duplication, as very substantial results have already shown.

The Main Committee is solely an administrative and policy-forming body, and does not pass upon the technical details of standards. The formulation of a standard is in the hands of a working committee, technically called a "sectional committee," made up of representatives designated by the various bodies interested. The Main Committee must approve the personnel of each sectional committee, as being authoritative and adequately representative of the various interests concerned. Producers, consumers, and general interests, are to be represented on every sectional committee dealing with standards of a commercial character.

Sponsor Bodies

In one important particular the method of work of the American Engineering Standards Committee differs from that of the other national bodies. This is the use of what are termed "sponsor" bodies. When the Committee was formed there were already a large number of organizations doing standardization work, some of whom had accomplished, and were engaged in, very important work. This led to a policy of decentralization. Each sectional committee is organized by, and under the leadership of, one or more of the principal bodies interested and known as sponsor.

Special provision is made for the approval of important standards in existence prior to 1920, without going through the full formal machinery of a sectional committee.

It is to be noted that each industry, or branch of industry, is wholly autonomous in its standardization work, the Main Committee not dealing with the technical matters in any way, but merely assuring that each body or group concerned in a standard shall have the opportunity to participate in its formulation, and providing systematic means of co-operation in the work.

The Committee has decided that "if it is the desire of any industry to have a general committee, representative of the industry as a whole, as a means of developing and correlating the standardization work of the industry, the arrangement will be eminently satisfactory to the American Engineering Standards Committee." Such a general correlating committee for mining standardization has been formed, the nucleus being two representatives from each of five leading mining bodies—the American Mining Congress, the American Institute of Mining and Metallurgical Engineers, the U. S. Bureau of Mines, the Mining and Metallurgical Society of America, and the National Safety Council.

If requested to do so by a responsible organization, the Main Committee calls a conference of the interested bodies to decide whether it is desirable that a given piece of standardization work shall be undertaken, and if so, what its scope shall be. In this, and in its work generally, the Committee is not an initiating body. Consideration will show that this policy is

very conducive, if not necessary, to cordial co-operative work. For example, if the Committee were to call such a conference on its own initiative, its action in doing so might be misunderstood and resented as an attempt to dominate, while by not taking the initiative it becomes perfectly clear that the purpose is to serve.

Machinery for International Standardization

The American Engineering Standards Committee is in touch with all the other national standardizing bodies, and is actively co-operating with several of them.

There are at present three international standardizing bodies—the International Electrotechnical Commission, the International Commission on Illumination, and the International Aircraft Standards Commission. Each of these commissions is composed of national committees in the different countries. The International Aircraft Standards Commission has a quasi-governmental status.

In the other fields there is as yet no machinery for general international standardization. Each national body deals directly and independently with any of the other national bodies with which it wishes to co-operate on any specific project. Plans are now being made in Europe for a conference in the spring of 1921 to further international standardization, and to take first steps toward systematizing methods of co-operation between the different national bodies.

European Activity

Early in 1920 I had the opportunity of visiting the national standardizing bodies of Belgium, France, Great Britain, and Holland. It is surprising to see the amount and the intensity of standardization work being undertaken in Europe. One continually heard the term "mass production," and the statement that the extensive introduction of it into industry through standardization is an economic necessity for Europe today. Dimensional standardization is being carried much further than has been attempted in America, and standardization on a national scale is being woven into industrial fabric much more intimately than it is here.

These conditions prevail to an extraordinary extent in Germany, where the economic pressure is so great. It is being

carried further than would generally be thought desirable in America. Considerable work is being done in the standardization of design, and in some cases uniform design of complete apparatus is proposed for the entire German industry. It is urged that a great increase in efficiency and economy in production and utilization will result from pooling experience and skilled in design, and that it will be of great value in foreign trade, for example, in maintaining service stations.

The standardization movement is one of co-operation throughout each branch of industry, and between the different branches of industry whose interests touch or overlap, and will inevitably lead to a large measure of international standardization.

For years there has been a growing feeling among leaders in industry, which was heightened by the experiences of the war, that our industries function too much as independent units, and not enough as articulated parts of a national whole. It is not too much to say that standardization offers a major opportunity toward the integration of our industries on a national scale, so that they may function in a truly national way.

STANDARDIZATION AT THE UNITED STATES BUREAU OF STANDARDS

By G. K. BURGESS

The Bureau of Standards welcomes the opportunity of participating in these first annual conferences of the American Mining Congress on standardization, and the director, Dr. S. W. Stratton, regrets he was not able to be present in person to take part in the discussions and present a statement of the work that the Bureau is doing in the field of standardization.

This Bureau was founded in 1901. At the present time it has a personnel of about 850, and is located in a 200-acre tract just outside of the city of Washington, D. C. In 10 permanent and several temporary structures the plant represents a capital expenditure of $4,000,000. The budget for 1920 is $1,200,000.

How the Bureau Works

The scientific and technical work of the Bureau is grouped in nine administrative divisions, which are arranged according to the subject-matter coming under the jurisdiction of the Bureau. These divisions are: Weights and Measures, Electricity, Heat, Optics, Chemistry, Engineering, Physics, Structural and Miscellaneous Materials, Metallurgy, and Ceramics. These lines of work were not all developed at once, but the Bureau has had a systematic and healthy growth directed largely by the same men who were associated with Dr. Stratton at the time of the Bureau's foundation. This has made for continuity of policy, and a rational, systematic, development along lines laid down in advance and carried out as opportunity offered.

At the time of the establishment of the Bureau, it was necessary, in the hearings before the Congressional Committee, to call in witnesses from many fields of work to demonstrate the advisability or even the desirability of the establishment of a Bureau concerned with standards. At that time there was no National, State, or Municipal body concerning itself with and responsible for standards of measurement on any comprehensive scale. In the field of materials there was the

American Society for Testing Materials, founded in 1898, which, from the start, had been concerning itself with the promotion of knowledge of the materials of engineering and the standardization of specifications and the methods of testing. The membership of this Society at the time of the foundation of the Bureau of Standards was lesss than 200, whereas now, as an evidence of the growth of the standards idea in the field of engineering materials, membership of the American Society for Testing Materials is some 2900 persons. About the time of the establishment of the Bureau, the large engineering societies began to interest themselves with the various aspects of the standardization field. This interest in standards culminated in the formation of the American Engineering Standards Committee in October, 1918, which after a year largely devoted to questions concerned with scope, organization, and methods of functioning is now well launched on a firm basis with a very rapidly expanding program. A list of the technical organizations of the country drawn up last year showed there were over 260 of such that are actively interested in one way or another in the subject of standards.

Co-operation Between Government Departments

In the Government Departments, during these 20 years, closer relations and interchange of experience in the formulation of specifications and standards has been developing, although some of the Departments have been and still are handicapped by an inadequately equipped personnel for handling such questions with entire satisfaction to themselves. The question may be asked, "What attitude does the Bureau of Standards take toward other organizations, Governmental, and especially non-Govermental, in the field of standardization?" This may perhaps best be answered by considering the relations in the past between the Bureau of Standards and such bodies. Let us take first the Government Departments: In the hearings preceding the establishment of the Bureau, representatives of the various Departments were asked to testify as to what help such a Bureau would be to their Department. In the light of future developments this testimony today makes very interesting reading. Representatives of one of the largest Departments requiring a great deal of high-class technical work testified that such a Bureau would render

no service to their Department. It is a matter of record, however, that this particular Department has called for the services of the Bureau more than has any other, and largely for the very reason that it has so many highly technical questions involving specifications, standards, and properties of materials and performance of equipment, that in the very nature of things it was inevitable that the existence of such an organization as the Bureau of Standards equipped for experimental work on fundamental constants, properties of material, and methods of measurement, would have to be used by such a department.

The Bureau has acted in an advisory or consulting capacity to many of the Government Departments on questions involving specifications and standards, and has carried out many investigations at the instigation of these Departments on matters primarily of interest to them.

Other Standardization Societies Desirable

We may state it as an axiom, that the Bureau of Standards encourages the formation and growth of any other organization, whether it be public or private, which has among its objects the progress or improvement in the standardization field and in the dissemination of knowledge concerning standards. The standardization field is one of practically unlimited extent, and each one of the numerous organizations in the country that are concerned with the subject has some particular phase of it that it wishes to cultivate. In so far as its facilities admit, the Bureau of Standards is ready at all times to work in harmony with, and when desired in co-operation with, all movements looking toward the improvement of standards and the methods of standardization. There are few, if any, aspects of the development of standards and specifications, at least concerning matters relating in whole or part to various branches of engineering, in which the Bureau of Standards can not be of some use. To refer again, as an example, to the work of the American Society for Testing Materials, it has been mutually advantageous to the Society and to the Bureau to work in close harmony in the preparation of specifications for engineering materials. A great deal of the experimental work outlined by the several committees of this Society has been carried out in the Bureau laboratories, and members of

the Bureau are represented on many of the Society's committees. We believe, and in this I can speak both for the Bureau of Standards and the American Society for Testing Materials, that this close co-operation and co-ordination of effort has worked to the very great benefit of the engineering public.

Again, the Bureau of Standards welcomed the founding of the American Engineering Standards Committee, on which Committee the Bureau has three representatives. It will be remembered that in the preparation of standards which are to be reported to the Standards Committee there is a "sectional committee" appointed to formulate a given standard, and there is one or more especially interested organizations named "sponsor" to push actively the constructive work on the standard. The Bureau of Standards has been designated as sponsor in the preparation of a considerable number of standards, including, for example, several in connection with the preparation of industrial safety-codes as follows: Electrical Safety Code, Gas Safety Code, Head and Eye Protection, Lightning Protection, Logging and Saw-Mill Machinery, among a list of 37 codes which are in various stages of completion.

A Wide Field in Standardization

The Bureau of Standards recognizes that the field of standardization is an extensive one; and the functions of the Bureau may be briefly stated as the development, construction, custody, and maintenance of reference and working standard and their inter-comparison, improvement, and application, in science, engineering, industry and commerce. For convenience, the Bureau groups standards into five classes: (1) "Standards of Measurement," which includes reference and working standards for measurements of all kinds for expressing the quantitative aspects of space, time, matter, energy, motion, and their inter-relations as illustrated by length, area, volume, mass, density, pressure, thermal, electrical, and other physical measurements, which have for their purpose to aid accuracy in industry, assist commerce in size standards, promote justice in daily trade, and facilitate precision in science and technologic research. (2) "Standard Constants." or what we may call natural constant or the measured numerical data rep-

resented by fixed physical constants, such as mechanical equivalent of heat, melting and boiling points, heats of combustion, electro-chemical, and atomic weights, and the like, which we have as an exact basis for study, experiment, computation, and design, furnish an efficient control for industrial processes in securing reproducible and uniformly high quality and output, to secure uniformity of practice in instruments and tables and aid laboratory research by reducing errors and uncertainty caused by the use of data of doubtful accuracy. (3) "Standards of Quality," which are illustrated by specifications for materials used in engineering, which fix in measurable terms a property or group of properties for determining the quality in question, securing high utility in the products of industry by stabilizing the standard of quality, furnishing a scientific basis for fair dealing, avoiding disputes or providing means to settle questions, promoting truthful branding and advertising as well as precision and the avoidance of waste. (4) "Standards of Performance," or specifications of operative efficiency or action for machines and devices. (5) "Standards of Practice," such as codes and regulations impartially analyzed and formulated after study and experiment into standards of practice for technical regulation of construction, installation, operation, and based upon standards of measurement, quality and performance; such, for example, are the safety codes above mentioned.

Specific Examples of the Bureau's Work

To give a complete account of the standardization work of the Bureau would surely take us far afield, but it may not be without interest to give a summary of certain of the standardization activities as illustrative of the methods of procedure, and emphasis will be placed on those cases showing our methods of co-operation with other bodies. In the field of fundamental standards of measurement and the determination of standard constants the Bureau considers itself the final authority for the country, but in the development of standards of quality, and more particularly in the establishment of standards of practice, the Bureau considers it does its most effective work in co-operation with the interested bodies.

Screw-Threads

Let us first consider briefly the work of the National Screw Thread Commission established by Congress on July 18, 1918, made up of representatives of the Government, the Society of Mechanical Engineers and the Society of Automotive Engineers and of which the Director of the Bureau of Standards is chairman. The task of this Commission is the establishment of screw-thread standardization from the standpoint of interchangeable manufacture, and includes the setting up of a series or system of threads with definite specifications as to form and dimensions expressed in measurable terms. The Commission has decided that the thread form should be that known as the "U. S. form"—there should be two series of threads, a coarse and a fine, and there should be four classes of fit provided for, loose, medium or standard, close, and wrench fit. There have been established a set of pitches and tolerances for each class, and the Commission still has to formulate a considerable number of rules regarding threads, tubes, taps, bar stock, and dimensions of bolt heads and nuts. The experimental work for the Commission has been carried out largely at the Bureau of Standards.

Research in Electrolysis

As an example of the co-operative method adopted by the Bureau in questions involving engineering practice on a considerable scale in various communities, there may be mentioned that of electrolysis survey and prevention. This is a problem that has been studied more particularly in its relation to conditions in cities and in some cases to inter-urban transmission, but nevertheless may have its applications in certain cases to the mining industry. The method of carrying out these investigations is, however, typical of the way the Bureau would take up problems falling in its field which might be desired by the mining industry. Briefly, our methods in electrolysis investigations have been the following: Field surveys are carried out on the actual conditions in the districts to be studied. This often requires, for example, modified forms of apparatus for measuring current flow in pipes and leakage flow from pipes. In fact, the electrolysis problem has required the development of a whole series of modified apparatus for

the purpose. There arise special problems such, for example, as the actual facts concerning the phenomena of corrosion of lead, and as what may be expected under the conditions of alternating current and of direct current. This requires laboratory as well as field research. From its surveys and experimental studies, the Bureau has been able in many cases to recommend modifications that have eliminated or greatly reduced the very harmful effects of electrolysis in cities. A not unimportant function of the Bureau has been its position of an impartial technical advisor as between the diverse interests.

There is also in existence an American Committee on Electrolysis, which represents all of the great national associations of utilities companies, and is co-operating with the Bureau in conducting extensive research in the field of electrolysis mitigation. The research program was formulated by the Bureau and approved by the Committee, and this research work will be carried out jointly. Some of the work under way is the effect of pipe drainage on underground systems, especial attention being given to the possibility of joint electrolysis on high resistance joints and interchange of current between drained systems. It will be seen from this brief statement that several aspects of this electrolysis branch of research by the Bureau may have direct application in the mining industry.

Standardizing Coal-Mine Scales

Another item that may be of particular interest to the American Mining Congress is the Bureau's work on investigation of mine-scales. In August, 1917, it was brought to the attention of the Bureau that a serious condition of affairs existed in the coal-fields of Allegany county, Maryland, as a result of disputes continually occurring between the miners and operators in regard to the condition of the scales and methods used in weighing the coal mined by the workers, upon which their wages depended. The miners distrusted the weighings obtained from the scales in use, and believed that they were not receiving the full amount of pay to which they were entitled. No method of remedying the situation had been found, and it had become so acute that a general strike was impending, and would certainly have occurred had not the Bureau promptly intervened and obtained a postponement of this action while an investigation was conducted. This

matter was considered to be of the greatest importance on account of the special necessity for continued production of coal at this time, when it is so vitally needed.

No attempt was made to test all the scales in the region, those being selected for test at mines where the friction between operators and employees was most pronounced. As a corollary to the test of scales, an investigation was conducted into the matter of average tare weights and other matters closely related to the accuracy of the weights obtained.

It was demonstrated that the grievances of the miners were in many cases well-founded. The scales had in many instances been improperly installed; no proper attention to their maintenance had been given throughout long periods of service; and, in at least one instance fraud in weighing was very strongly indicated. The result of all these conditions was that very serious errors of use were common—not a single scale examined being within the tolerance allowable in such work; moreover, important errors were in every case in favor of the operator.

This work is being continued with additional portable equipment, and the investigation extended into new mining regions including the bituminous fields of Kentucky, Tennessee, Ohio, West Virginia, and Georgia. In general, it may be said that the tests made were found to have a very desirable effect on the regular production of coal. In those cases where the scales were found accurate, distrust and suspicions in the minds of the workers were allayed, and operations continued with better feelings on both sides; in other cases where scales were found to be inaccurate, corrected measures were applied, and both parties to controversies were satisfied.

Sulphur and Phosphorous in Steel

Still another type of co-operative work to which reference may be made is the metallurgical investigation under the auspices of a Joint Committee representing all interested parties including Government, manufacturers, specification making bodies, and large users of steel, to determine from a series of experiments carried out on a large scale both in the plants and in the laboratory of the effect of sulphur and phosphorous on steel, for the purpose of arriving at fair limits of these deleterious elements in the specifications for steel.

From the above illustrations I trust to have made it evident that the Bureau of Standards in its standardization work takes the position that it can be most effective in co-operating with those organizations both public and private who are interested in developing standards in any particular field. It is undoubtedly the case that the mining industry will find it to its advantage to call on the Bureau not only for experimental work in determining fundamental questions of fact regarding measurement and the quality of material entering into mining equipment and accessories, but also I trust that you will find it beneficial to take advantage of the experience that the Bureau of Standards has had in the past in developing standards in other lines, and I am instructed to say by the Director that the Bureau of Standards is at your disposal for this purpose.

Permit me to expresss my admiration for the spirit shown in these Standardization Conferences, and my astonishment at the surprising amount of progress already made in the standardization field as related to the mining industry. It is hardly necessary for me to emphasize again as so many speakers have done, the economic and far-reaching benefits of standardization which has abundantly been proved to be worth many times the cost in not only money, but in time and thought and energy spent upon it. On behalf of the Bureau of Standards, therefore, I extend to this Standardization Conference our most hearty congratulations and best wishes for continued prosperity in the standardization field.

MINE ACCOUNTING*

By LAWRENCE K. DIFFENDERFER, Treasurer, Vanadium Corporation of America, New York

Each mining company seems to use a different system of accounting. Because of this, and because mines are frequently in undesirable regions, companies experience great difficulty in securing competent mine accountants. Recognizing the necessity of a uniform system of accounting, this paper is submitted, being the result of 12 years of actual experience as a mine accountant. It is not intended to cover the technical part of mine accounting, but the practical side; and is for operating heads.

Too much care cannot be exercised in the selection of the mine accountant. He is an invaluable asset. He must be more than a bookkeeper, and should understand all operations about a mine.

Mine accounting should be divided into three general divisions, namely: (1) "Operating Expense"; (2) "Capital Account"; and (3) "Deferred Charges."

Operating Expense

This account should cover all expenditures incidental to producing the product, including items of repairs and maintenance, as well as reserves for depreciation, depletion, obsolescence and development.

Capital Account

This account should include all expenditures incidental to the creating of a permanent or fixed asset; and proper reserve for depreciation, obsolescence and depletion should be set up and charged to operating expenses concurrently.

Deferred Charges

Unless the general balance-sheet reflects the true financial condition of a company, it is worthless. The true current position of a company is the most important for all financial purposes. The cost sheet is also worthless unless true cost is shown, and the greatest care should be exercised to keep the costs absolutely correct and uniform.

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*An abstract.

Wherever the shrinkage or overhead stoping system is in use, generally one-third of the ore broken in any given period is hoisted, and the remaining two-thirds held in the stopes until the level is stoped out.

In one instance, where 500,000 tons of ore had been left in stopes, which at a breaking cost of 44 cents per ton, represents current assets amounting to $220,000, this was not reflected in the current position of the company on the general balance sheet. It therefore follows that wherever more ore is broken in any given period than is hoisted, credit should be given for the same to operating expense and charged to the proper asset account in the current position of the company; and whenever more ore is hoisted than is broken, operating expense should be charged for the same and this same account credited.

It is sometimes stated that this asset is questionable on account of the hazardous operation, but it should be conceded that the main shaft should be of a permanent nature, otherwise all operations in the mine are jeopardized, and should the walls cave and the ore which is broken in stopes be lost, it is a direct charge to income and should not be taken through the current costs.

If prospecting for ore proves its existence, then the expense of exploration should be considered as a deferred charge; if it does not prove ore, then the cost should be charged direct to income or profit and loss.

Development is a deferred charge and should be so considered. The main-shaft station, grizzly, and loading pockets are capital expenditures, and should be capitalized and depreciated. This can be done on the basis of number of tons hoisted, or on a percentage basis.

Drifts and crosscuts are usually considered as development; and raises and chute holes to a point of coning out are included under this head. Ore is usually recovered in development. It is reasonable to assume that the cost of tramming, hoisting, and milling ore received from development is the same as ore which comes from stopes, as the ore from the former and that from the latter cannot be kept separate, and therefore becomes mixed. So instead of keeping these costs separate—which costs are always an estimate based upon percentages—it is better to credit development ore at the breaking cost of the ore in the stopes.

Depletion

Generous reserves for depletion should be set up and credited to reserve for depletion, and charged to operating expense, and so shown on the cost sheet. The simplest and best method is to take the number of tons of ore that is in reserve, as calculated by a disinterested engineer, and divide the same into the cost of the property, exclusive of the amount expended for development, or for buildings and machinery. It is wise to be conservative in this matter, and not let the reserve be stated higher than that can be justified.

Retirements

Whenever a unit of equipment or building becomes obsolete or useless, and is retired, the proper account should be credited with same at cost. If the unit is sold, then the purchaser's account—accounts receivable—should be charged at the sales price. Reserve for depreciation should be charged for the depreciation set up on said unit of equipment, and operating expense either debited or credited for the loss or profit on the same. Sometimes it is advisable to create an account on the cost sheet, entitled 'retirements,' in order to keep this expense separate.

Depreciation and Obsolesence

Generous reserve should be set up for depreciation and obsolescence, based upon past experience. The Revenue Law allows the setting up of depreciation reserves based upon the theory that if the unit of equipment or building has been repaired, then it has not depreciated by that amount which was expended for repairs and maintenance in said period. Therefore, the depreciation rate should take this fact into consideration at the time of creating said rate, and the repairs and maintenance should be deducted in setting up the reserve.

There are only six sub-divisions of accounting necessary at a plant; these are: (1) 'Working Fund'; (2) 'Payroll'; (3) 'Stores (materials and supplies)'; (4) 'Shipping (product and miscellaneous)'; (5) 'Production Records'; and (6) 'Depreciation Ledger.'

[Mr. Diffenderfer's paper, of which the above is an abstract, included 13 forms of reports applying to these sub-divisions, but as it is impracticable to reproduce them, they are omitted.]

STANDARDIZATION OF METAL-MINING ACCOUNTING

By T. O. McGRATH, Bisbee, Ariz.

Even though a mining property be equipped with the best mechanical appliances, has an organization of high ability, and has employes embued with the spirit of co-operation, the business cannot be intelligently managed without a knowledge of the results of operation and the condition of the business for each operating period, for each department, and for the business as a whole. Such information is obtained by proper accounting.

Accounting for metal mines consists of three main groups, namely, (1) General Accounting; (2) Cost Accounting and Statistics; and (3) Economic Accounting.

General accounting determines the condition of the business, and the profit and loss for each operating period. Cost accounting determines the profit and loss, and the variation in the cost of each department for each period of operation. Economic acounting determines which of several methods of operation is most profitable under different market prices of metal.

General accounting and cost accounting for metal mining have been fairly well developed during the past 10 years, but mostly along individual lines. So far, little has been done in economic accounting, although great savings could be made by it, especially during periods when there are wide fluctuations in metal prices.

This discussion will be limited to the fundamental principles of general accounting, and to recommendations for a standard system of accounting for metal mines.

General Accounting

I am well aware of the fact that no standard system of accounts can be devised that would be applicable to each separate department, due to different mining and metallurgical methods. However, there are certain basic principles that can be followed, upon which the accounting and cost structure can be built to obtain uniformity in the accounting and cost data for each operating unit having similar problems.

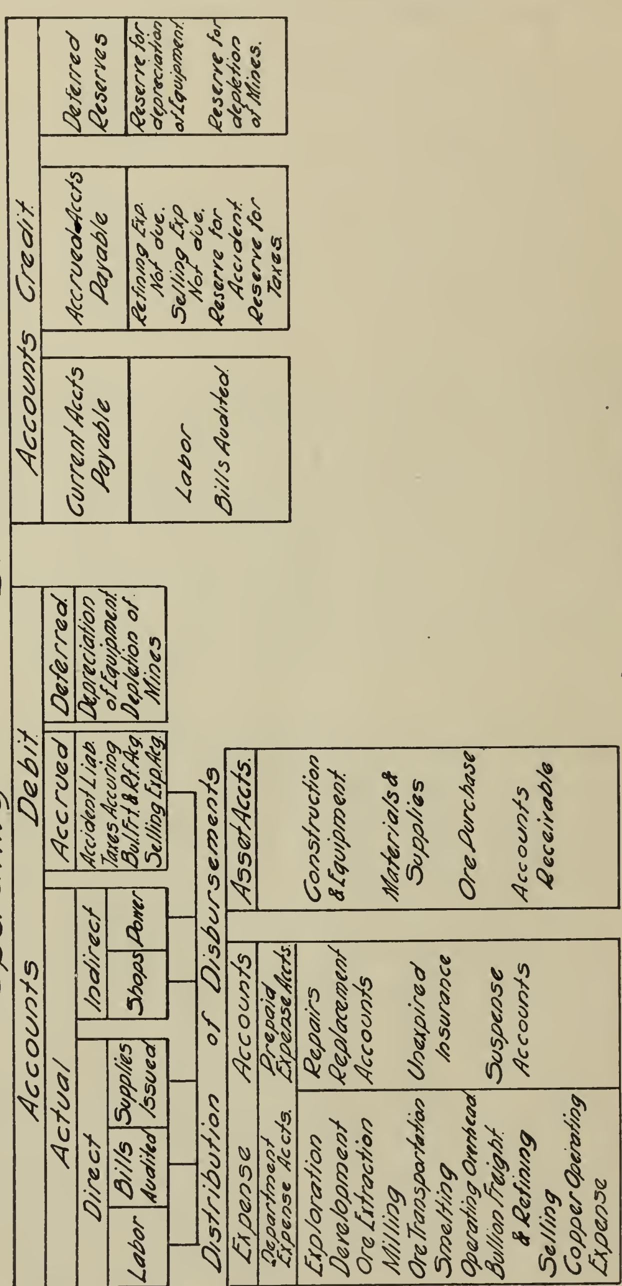
Operating Disbursements.
Accounts Debit.
Actual
Direct
Labor
Bills Audited
Supplies Issued
Indirect
Shops
Power
Accrued
Accident Liab.
Taxes Accruing
Bul. Frt. & Rf. Acg.
Selling Exp. Acg.
Deferred.
Depreciation of Equipment
Depletion of Mines
Accounts Credit.
Current Accts Payable
Labor
Bills Audited
Accrued Accts Payable
Refining Exp. Not due.
Selling Exp Not due.
Reserve for Accident
Reserve for Taxes
Deferred Reserves
Reserve for depreciation of Equipment.
Reserve for depletion of Mines.
Distribution of Disbursements
Expense Accounts
Department Expense Accts.
Exploration
Development
Ore Extraction
Milling
Ore Transportation
Smelting
Operating Overhead
Bullion Freight & Refining
Selling
Copper Operating Expense
Prepaid Expense Accts.
Repairs Replacement Accounts
Unexpired Insurance
Suspense Accounts
Asset Accts.
Construction & Equipment
Materials & Supplies
Ore Purchase
Accounts Receivable

Chart No. 1.

Chart I shows the fundamentals of the business of mining in the natural order that must be accounted for in any complete and correct system of mine accounts. The business begins with the capital investment. Production operations start with the disbursements of working capital, which are made in order that production may be obtained. This is followed by sales of the production in order that receipts may be created by delivery of the sold product to transportation agents, which in turn is liquidated by cash payments from customers, and this cash is used with which to meet new disbursements, and so forth. The business of operation continues to rotate through these five stages as long as there is production. At the end of each period, results of operations are shown in profit and loss, dividends and surplus, and the condition of the business is shown by a balance-sheet.

These accounting and business principles are uniform for all metal mines and the general accounting for metal mines could be standardized with the exception of the expense accounts, which would vary to conform with the different methods of mining and treatment.

Accrued or Cash Basis

In working out a system of accounts, the first matter that must be decided is whether the accounting shall be kept upon an accrued or cash basis. At the present time, most of the large corporations keep their accounts upon an accrued basis, which is necessary to obtain a complete and correct system of costs. Therefore we may safely state that the accrued basis of accounting has been accepted as standard in metal mining.

Standard Statements of Profits and Loss, and of Balance-Sheet

There are two accounting statements that are of vital interest to the officers, stockholders, and directors of each company; also to other units, and to the investing public. These are the income, or profit and loss statement, for the month and year, and the balance-sheet or statement of the condition of the business at the end of such periods.

There is no reason, except lack of interest, for not having these two statements uniform for all units. Some companies publish clear and complete statements of profit, and of the condition of their business properly grouped and arranged;

while the reports of others are so drawn and arranged that it is practically impossible, even for the officers, to obtain a satisfactory analysis therefrom. While there has been a great improvement in the form and nature of these two statements since the enactment of the income and excess-profit tax laws, there is no reason why these should not be further improved and made uniform for the whole industry. This could easily be accomplished by agreeing upon uniform grouping of the profit and loss statement, and balance-sheet.

If this were obtained, the results and conditions of each operating company could easily be compared with that of other units, and would be of great value to all concerned. In the past, the result of improper and incomplete statements of earnings has furnished the labor agitator with good argument with which to convince workmen that the organization by which they were employed could well afford to make unreasonable concessions, as well as leading the taxing commissions to believe that such mines should pay excessive taxes. Also one of the reasons for the lack of interest in copper has been attributed to the lack of proper presentation to the general public of the facts of the industry and its possibilities. To give the consuming and general public clear and concise facts would without doubt be of general benefit to the industry.

Cost Accounting

I do not believe that it is necessary to emphasize the need of proper costing; that is self-evident.

At the present time, metal mining includes mines, mills, smelters, and refineries, principally large units, employing hundreds, and in some cases, thousands of men. The saving or loss of a few cents per man per day in the use of powder, tools, and other supplies, and in 'dead' time of labor, or effort improperly expended, results in some cases in the difference between profit and loss, especially during times of low prices for metals.

Cost accounting in itself cannot obtain efficiency, but once efficient standards have been obtained in the different departments of the organization, proper accounting and costing will then show the variations from these standards and the source of the variation, enabling the manager, department heads, and

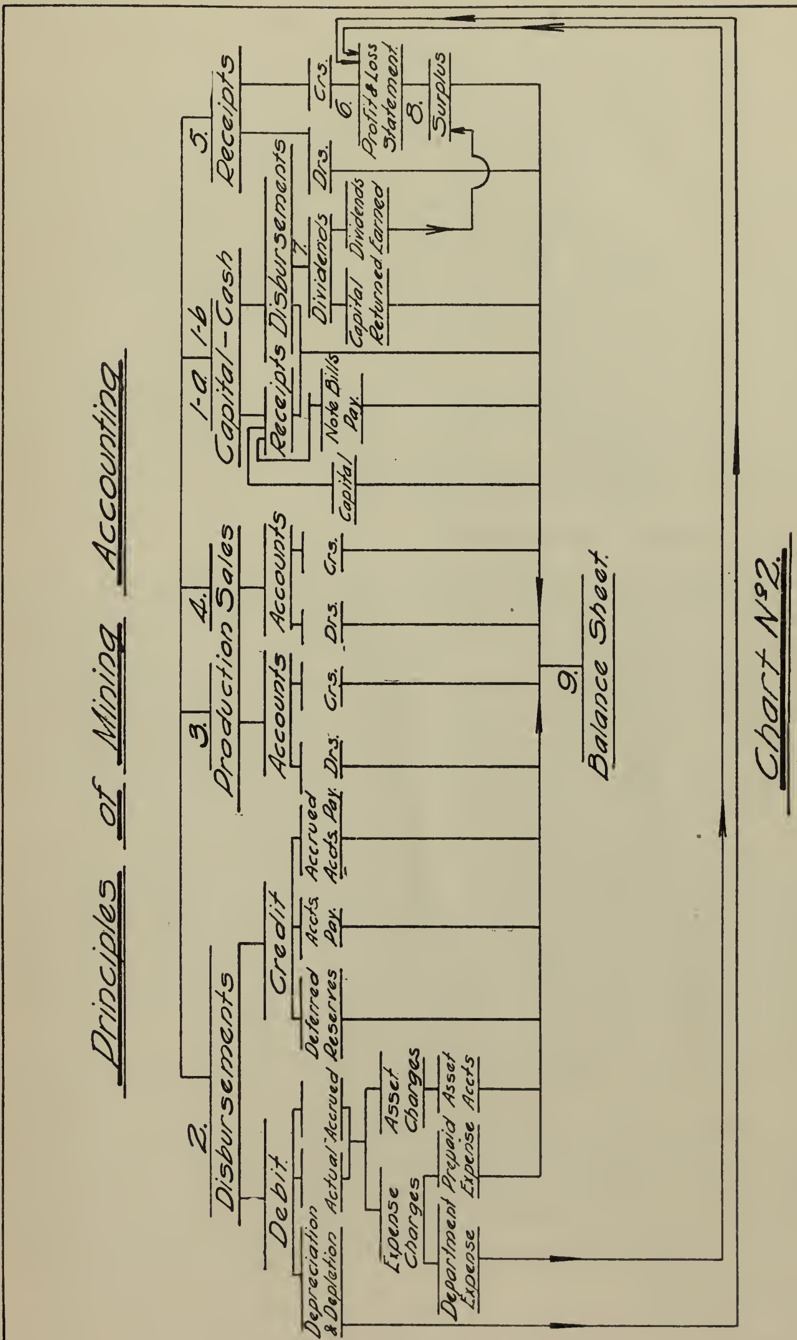
Principles of Mining Accounting
1-a. 1-b. Capital-Cash
Receipts
Disbursements
Capital
Note Bills Pay.
Capital Returned
7. Dividends
Dividends Earned
5. Receipts
Drs.
Crs.
6. Profit & Loss Statement
8. Surplus
4. Sales
Accounts
Drs.
Crs.
3. Production
Accounts
Drs.
Crs.
9. Balance Sheet
2. Disbursements
Credit
Deferred Reserves
Accts Pay.
Accrued Accts Pay.
Debit
Depreciation & Depletion
Actual
Accrued
Expense Charges
Asset Charges
Department Expense
Prepaid Expense
Asset Accts

Chart No. 2.

others to correct immediately any deficiency or waste before that unit has become unprofitable.

I do not believe that it is necessary to emphasize the need of uniformity in compiling the accounts and costs by each company in metal mining. If each one compiled these in a uniform and correct manner, results in the various mines and plants having like methods and problems could be compared, and proper standards of achievement could be easier and more quickly determined. Such uniformity would tend to broaden the view and interest, and increase the co-operation among the different units of the industry, as well as to minimize personality and prejudice, not only among the superintendents of labor, but among the workmen themselves, who become prejudiced by the lack of uniformity in different mines or even in different divisions of the same mine.

Analyzing the Disbursements

Costing is concerned with analyzing disbursements and production. In order that the former may be correct and uniform, disbursements should be segregated into the different groups of expense, prepaid expense, and assets. The expense should then be segregated to each department, sub-department, and departmental unit. Production should also be segregated to each department and unit, so as to allow of the determining of the cost per unit of production or of operation.

In Chart II, entitled 'Operating Disbursement Accounts,' are all the disbursements segregated into expense and assets that are involved in the operation of a mine producing smelting ores. This chart does not show the administrative disbursements for expense and investments, as these are not generally under the direction of the manager.

This chart shows a complete record of all disbursements whether current or actual, accrued, and deferred. It is best to make up such a chart of disbursement accounts in order to insure that all disbursements are being recorded each month in proper manner. Also, such a chart fixes the matter more clearly in the mind, and acts as a guide and reference for those who perform the work of compiling and segregating disbursements.

Principal Costs

The present practice is to keep four kinds of costs, such as:

(1) Production; (2) Departmental Production; (3) Unit Operating; (4) Unit Construction and Equipment Costs.

Of course there are the estimated costs that are made up by the engineering department in connection with proposed new construction and equipment, against which the actual costs are checked. The production cost is obtained by dividing the total production into the items of expense appearing in the profit and loss account. In determining the departmental production cost, each department such as ore extraction, or mining, milling, smelting, etc., should be divided into sub-departments to conform to the actual organization and work in each of the departments. Then the expense of the department should be segregated to each of these sub-departments, and the expense for each of the sub-departments further segregated into at least six elements, namely, (1) Labor; (2) Supplies; (3) Power; (4) Repairs; (5) Replacements; and (6) Indirect expense.

By adding the amount of the expense of each element for each sub-department, the total expense for the department and for each element is obtained, and the dividing of the production of the department into the amount of expense gives the cost for each element for each sub-department, and for the department as a whole. By segregating the expense into these six elements, it is possible to trace the variations in costs from month to month, and informs the department head where and what to investigate. This method of determining the departmental production costs is already in general practice by several groups of mines. The differences are in the naming of the accounts for the different sub-departments, and in the dividing of the sub-departments; but these are matters that could be easily remedied.

The same method should be followed in determining unit operating costs except that the elements of labor, supplies, repairs, replacements, and indirect expense should be detailed into as many items as it is found necessary to enable the tracing of all fluctuations.

The unit operating cost is the cost kept on each operating

unit or sub-department, as for instance the cost of steam, air, electricity, cost of sinking, stations, drifting, raising, stoping, etc., and are figured upon the operating unit instead of upon the production unit for the department. It would be of great advantage to have such costs obtained uniformly by all mining units.

Methods of Determining Costs

There are two principal methods of determining departmental and unit costs: First, the Departmental Unit Method; and second, the Departmental Pro-rated Method.

The former is the dividing of each department into sub-departments, and these into units regardless of whether or not they are productive or overhead departments, and the segregating of the expense into the proper elements and the distributing of the expense to each sub-department and unit which is kept intact.

The second method segregates the departments and expense in a like manner, but further divides the sub-departments into productive and overhead and pro-rates the expense of the overhead departments to the productive departments.

This latter method is the one used by manufacturing concerns making more than one article for sale, when it is necessary to get the exact production cost for each article in order to determine the proper selling price. However, in mining, where there is only one principal product, with sometimes a by-product which is treated as a credit, the pro-rated method is not necessary, and only increases the amount of bookkeeping and segregating, and makes the costs more complicated and difficult to comprehend and analyze. The Departmental Unit Method should be the one adopted as standard.

Uniformity of Cost Determinations

While it is not probable that all unit and departmental production costs of metal mining will be standardized, nevertheless the industry could be divided into the several groups that mine and treat ores in a similar manner, and the cost for each of these groups could be standardized and determined uniformly.

At the present time there are possibilities of large savings in

fuel and power at most properties. It is only occasionally that the power costs are accurately determined. There are usually large wastes in the use of supplies and in the purchasing of improper supplies, which could be limited by correct cost methods properly presented.

The determining of boiler horse-power, the amount of compressed air, and of all power and other unit costs should be and could be made uniform. In some cases the drifting cost in one mine will be based upon the actual expense at the face of the drift, while in another mine in the same district this cost will include the pro-rated cost of overhead. This destroys the possibility of comparison and applies to all costs when compiled by different methods.

Uniformity in Compiling Efficiency Factors

Not only should the cost data of expense and production be compiled in a uniform manner, but the production factors necessary to determine efficiency should be uniformly kept. For instance, the shifts of men employed in a certain department or in a certain unit should be compiled in like manner each month, and for each unit of the industry, so that if there is any variation in the output the compilation will show the facts. The feet advanced per man-shift in drifts and raises, and tons obtained per man-shift in stopes, etc., as well as the methods of determining mill and smelter recoveries and losses, should be compiled by all companies in the same manner. This would enable one mine, mill, or smelter to determine quickly whether or not the efficiency of the men in its plant was equal to that of the employes in another plant, working with the same equipment and under the same conditions, and would enable the department heads and supervisors to ascertain whether or not better results obtained elsewhere are due to better methods, equipment, or efficiency.

During times of rapid advances in wages that are based on a sliding scale, as well as rapid advances in prices of supplies, the cost for one period may show a decline over a previous period, in spite of increase in wages and supplies, due to an increase of efficiency in the workmen. Also, during declining prices and wages the cost may show an advance in spite of the decline due to a loss in efficiency. Therefore, in order to know

positively the reason for increase or decrease in the cost for each period, the necessary production factors should be compiled, as well as the cost in dollars. This data should be and could be ascertained in a uniform manner by all units of the metal industry.

Necessity of Departmental Co-operation

Most of the metal produced comes from mines of large organizations. It is the tendency for each department of such companies to isolate itself from the others and to become prejudiced and indifferent as to the work of the other departments, and the business as a whole. When such a condition exists, it is difficult to obtain correct accounting and cost data, and to present in proper form the accounting and cost results for each department, and of the business generally.

Close association between the heads of different departments leads each to a broader knowledge of the business, and to value the viewpoint and to profit from the knowledge and experience of the others, as well as tending to eliminate friction and misunderstanding, and to develop breadth, consideration, tact, judgment, and the ability to co-operate and manage, to the benefit of the whole organization, as well as for each department.

Of course, it is the duty of the manager to co-ordinate the work of each of the departments, and to correct the extremes resulting from isolation. However, this is difficult to accomplish when there is not a close working contact between the departments, or when the manager has obtained his preliminary knowledge of the business as the head of an isolated department. The better the organization and working contact, the greater the benefit that can be obtained from accounting and costing.

In the mining business, as in other lines of industry, the matter of first importance in connection with an expenditure is whether it is profitable. This point is lost sight of more often than is usually realized, due principally to departmental isolation.

In some large organizations, thousands of dollars are expended each month in compiling accounting and cost data that

are never used except for a record, due to the fact that they are ready at such a late date, or in such a manner, as to be valueless to the heads of operating departments. This waste could be turned into a profit by correct presentation of costs and a closer working agreement between the different departments.

Uniform Determination of Sales Price

There is no uniformity at present in the recording of sales prices received for metals. For instance, in copper and lead mining, some small producers will show the price received for metal at the net figure received from the custom smelter; while some of the large producers will give as the price received the net price f. o. b. New York; and again others give the New York price less commissions; while others will show as the sales price the actual delivery price. This makes it practically impossible to compile accurate statistics of prices received for metals, and in some cases where the deductions of smelters or sales agents are ignored, the costs are incomplete and show at less than actual. This could be easily remedied by adopting the gross settlement price as standard.

Summary

A brief of the principal points of this discussion shows that there should be an earnest endeavor to obtain in metal mining the following:

(1) A condensed standard form of profit and loss statement in correct order giving the actual results of operations.

(2) A standard form of balance-sheet arranged in proper groups and in order showing the true condition of the business at the end of each period.

(3) A standard system of expense accounts based upon the unit or control system, for each group of the industry.

(4) Uniformity in the determination and compiling of production and operating factors, and of recoveries and losses for use in obtaining costs and efficiency.

(5) A uniform method of recording sale prices received for metals.

In working to obtain standardization as above set forth, we should begin at the top and work down as far as practicable to carry out standardization of procedure without interfering with individual requirements, and then confine efforts to obtaining uniformity in determining production and operating factors used for costing or measuring efficiency.

I have tried to set forth the principal advantages that would accrue from such standardization. The reward of such an achievement is certainly great enough to justify our best efforts.

A STANDARD SYSTEM OF ACCOUNTING AND ANALYSIS OF COST OF PRODUCTION

Presented by T. T. BREWSTER, of the National Coal Association

The object of the National Coal Association Committee's* work is to propose a standard system of accounting under which all coal operators, so far as the particular circumstances of each case will permit, will classify their operating expenses for labor and material in the same way, to the end that true, detailed, and comparable statements of cost of production may be readily obtained; also that all operators shall make the same distinctions between capital and operating expenditures, so that the vital matters of depreciation and depletion and obsolescence may be treated with uniform consistency in accordance with law.

Preliminary Considerations

Before discussing the details of an accounting system, it is useful to emphasize the fundamental truth that every coal mine consists of: owned or leased coal deposits, plant, equipment, and development.

They all depreciate together as the coal is exhausted, for when the coal is gone, or the right to the coal has elapsed, the plant and equipment have little or no value and the development is lost.

Capital investment in a coal mine is not a permanent asset; it is only an outlay preliminary to the extraction of the coal; it is merely an advanced or deferred charge upon future income, which capital, if recovered, must be recovered with the current expenses of operation out of the proceeds of coal sold.

In coal mining, the exact unit for the measurement of work done is the ton of coal mined. It is also the exact unit for measuring depletion of mineral, wear and tear from use of equipment, and exhaustion of development. Development is a mere easement, the value of which disappears when the coal is gone.

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*The Committee consisted of C. E. Backus, T. T. Brewster, W. M. Henderson, J. C. Osgood, and Erskine Ramsey, with W. B. Reed as secretary.

A coal mine being, as emphasized, made up of several elements, all depreciating as the coal is mined, such depreciation is composite, accruing at a rate concurrent with the rate of extraction. The necessary rate per ton being determined, the aggregate depreciation for any accounting period should, of course, as far as practical, be distributed among the various elements in proportion to their respective costs or value.

The doctrine that measures depreciation of coal mining plant and equipment in terms of time—excepting of course, some leasehold propositions—is fallacious, as tested by the further assertion that a completely equipped mine could be maintained indefinitely without depletion or wear and tear if no coal were mined, by minor repairs. Therefore, we insist, as a general rule—excepting some leaseholds—that the correct measure of the depletion and depreciation experienced in mining coal is the ton of coal mined.

After a coal mine has been developed and equipped to its planned output capacity, charges to its Capital Account should cease, and thereafter there will be few if any permissible charges to that account.

At the end of each month, Operating Account should be charged, and Depreciation and Depletion credited with an amount equivalent to the depreciation rate multiplied by the number of tons mined during the month. At the end of the year, Depreciation should be charged with the year's accumulation, and the respective elements of the mine written off in proper proportions. If, however, the operator prefers to allow total Depreciation to stand as a credit on the ledger, it should be exhibited in the Balance Sheet as a deduction from the cost of property. Irrespective of which way it is handled on the general ledger, the proper reducing entries should be made against each element of the property in the plant ledger.

In the case of mines operated under lease, if the leasehold rights run longer than the probable period required to exhaust the estimated available coal, the same factor of Depreciation applies; but if the life of the lease is shorter than the probable period required to get all the coal, the monthly charge to Operating Account and corresponding credit to Depreciation should be such proportion of the cost of the mine as one month is of the remaining term of the lease.

Funds representing Depreciation accumulations, if not periodically applied to the retirement of outstanding securities or obligations, should be kept liquid for that purpose or invested in assets distinct from the depreciating property.

Before any profit or net income can be realized, current expenses for labor and for material consumed, current repairs, replacements, and depreciation must be made good out of gross income. Hence, sound consideration of the nature of investment in coal mining or any other wasting industry dictates that all outlay must be clossified and dealt with as follows:

(a) The initial cost of the mine in its entirety, chargeable to Capital Account—which must be redeemed by periodically setting aside, from current gross income, sufficient amounts to replace such investment within the life of the mine. It is obvious that the fund thus derived must be held inviolate for ultimate capital redemption, and if not applied immediately to the retirement of outstanding securities, invested in assets separate from the depreciating property or kept liquid in the business.

(b) The cost of additions and betterments, so large that such costs should be capitalized, must likewise be redeemed by setting aside from gross income adequate provision for reimbursing such cost during the life of the mine.

(c) To ordinary Operating Expense should be charged the cost of repairs and replacements of plant and equipment, and also cost of additional equipment necessary because of the extension of workings to maintain the normal output.

Distinction Between Capital and Operating Expenditures

The drawing of distinctions between capital and operating expenditures, in the accounting involved in permanent enterprises, is a favorite field for discussion among accountants, but in the case of coal mining or other wasting enterprises, experience teaches that the field for discussion, if indeed there be any, is extremely limited.

After a coal mine has been developed and equipped to its contemplated or possible capacity, it is a constant consumer of material and supplies and equipment, which, though nominally of a durable nature, are subject to destructive wear and tear,

by reason of the uses to which they are put, and all these appliances must be kept in repair to do their work or the output can not be maintained.

Mules and pit cars are constantly worn out, and have to be replaced, and as the working faces advance with the exhaustion of the coal, the length of haul, and consequent time of circulation of pit cars between the working face and dump increases, more motors, mules, and pit cars have to be supplied to maintain the output, and the more of these in the mine, the greater expense for replacements and repairs.

Also, with the advance of workings, more rails have to be laid and more copper wire or other conductors put up to carry power to the working forces to maintain the output. They remain in place until the mine is exhausted, and when they are recovered have but little net scrap value. In fact, any net salvage is relatively very small.

The fact that these expenses are continually recurrent and practically a fixed factor in the cost of production per ton from year to year, prove that they constitute an operating rather than a capitalizable expense.

Obsolesence

In addition to the provisions for depreciation and depletion to replace the capital sum invested in depreciable property and charges for ordinary working expenses, Operating Account should be charged with the residual value of property (after deducting depreciation, which has been or should have been charged, and insurance) that may be destroyed by catastrophe; also Operating Account should be charged with the residual value over accrued depreciation and salvage of any property discarded or that has become useless or obsolete before the end of the natural period of its usefulness.

Necessity of Detailed Analysis

If the only object of an operator's periodical statements were to exhibit the financial results of the period covered, or to contribute to general statistics, a short form with a few sub-totals and their extensions would be all required; but the successful solution of the problems facing the industry demands intensive management and economy, and as intensive

management means careful and intelligent attention to detail, analytical acounting is necessary.

The operating executive should have a report from each mine, which, read in the light of his knowledge of the property, will be a comprehensive narrative of what has been done, and reflect the physical conditions met with during the period covered by the report, and exhibit a clear statement of the cost of labor and material expended, classified in accordance with the natural sub-divisions of the work that has to be done in and about a mine, so that the economy and efficiency with which each thing has been done can be studied critically.

In the majority of cases, the natural sub-divisions of the work in and around a coal mine are as follows:

1. Mine office.
2. Superintendence.
3. Engineering.
4. Mining.
5. Timbering.
6. Deadwork.
7. Tracklaying.
8. Drainage.
9. Ventilation.
10. Haulage and hoisting.
11. Dumping and tallying.
12. Preparation.
13. Railroad car loading and yard expense.
14. Power.
15. Repairs to buildings and permanent structures.
16. Sundries.

To these sub-divisions should be distributed the items below:

Mine Office Expense—Clerk, bookkeepers, janitors, books of account, stationery, office funiture and supplies, telephone, light, heat, etc.

Superintendence—Wages of superintendents, bosses, mine examiners, watchmen, and all other direction and caring for the property in a supervisory capacity. Safety lamps, mine telephone, etc.

Engineering—Mining engineer, helper, engineering instruments and supplies, maps, blueprints, etc.

Mining—(a) Hand mining. Miners, helpers, shot-firers, etc. (b) Machine mining. In machine mines this item should be sub-divided into undercutting and pit-car loading. Undercutting should be charged with

(a) Generation and transmission of power, that is, the proportionate share of cost of power generated and its transmission to machines (see note on power below).

(b) Maintenance of machines, that is, repair parts, machine picks, cable for electric machine, and air-hose for air machines. Shop and repair-men employed on machines and labor of blacksmiths sharpening or making bits and such part of the time of head electrician spent in maintenance of machines.

(c) Operating machines: To this sub-division should be charged the wages of machine runners and helpers, bit carriers, oil, grease and waste, oil-cans, hand picks, pick handles, jacks, machine-shovels, etc. If machines are not equipped with self-propelling trucks and the machines are moved about their sections by mule haulage, such haulage should be charged to operating machines.

Pit-car loading needs no comment.

Timbering—Though timbering is imposed by physical conditions and is closely incident to work at the face, it is a significant item, and should stand by itself. To this sub-division should be distributed wages of timbermen and helpers, the cost of props, cap-pieces, cross-bars and other timber used in advancing work, such cost including freight and the cost of unloading and handling at the mine, with the expense of preparing and delivering to the working face.

Deadwork—As every mine presents physical conditions peculiar to itself, no two mines being alike, and as the physical conditions fluctuate as the work progresses, in order to work out comparable statements and records, deadwork should be classified in accordance with its nature, such as yardage, premium for narrow work, shooting rock, lifting bottom, taking down top, stowing and dumping gob, cleaning up falls and re-timbering after them, handling squeezes, mine fires, or any other work imposed by adverse physical conditions.

Tracklaying—While track is immediately connected with and necessary for the transportation of coal to the shaft bot-

tom, and hence a necessary item incident to haulage, it has long been regarded as a significant item in the cost sheet, and should stand by itself.

To this account should be charged rails, ties, spikes, and fastenings, and the labor of grading roads and tracklaying in advancing work. Repairs to track should be charged to Haulage and Hoisting, under maintenance of way.

Purchases of track material should be charged to track material account, and as the material is taken into the mine it should be credited and charged Tracklaying.

Drainage—To this sub-division should be charged the cost of labor employed in connection with the ordinary removal of water from the workings of the mine, with the expense of repairs and maintenance of pumps, pipe-lines, drains; also the proper proportion of power used. In some regions and in deep mines the tonnage of water handled and consequent consumption of power is very heavy.

In the event of a flood or extraordinary inflow of water, the expense of recovering the mine or flooded workings should be shown as a special and separate charge to Operating Account.

Ventilation—To ventilation should be charged proper proportion of Power expense to represent power used in driving fans. If cross-cuts are driven narrow because of physical conditions, the yardage should be charged under Deadwork.

Labor and material used in closing cross-cuts, constructing overcasts, mine doors, curtains and brattice, should be charged to Ventilation; also expense of cleaning and repairing air-courses. Repairs and lubrication of fan and fan engine, pressure gauges, etc., should be charged to Ventilation.

While trappers are rendered necessary in connection with ventilating doors, their work is incident to haulage of coal, and their wages should be charged to Hauling and Hoisting under conducting transportation.

Haulage and Hoisting should be separated into

1. Generation and Transmission of Power; that is, the proportion of expense of generating power and the construction and keeping up of transmission-lines and haulage circuits.

2. Care and Maintenance of Equipment—(a) Hoisting and haulage engine repair parts, lubricants, packing and waste, and wages of hoisting engine-man and mechanics employed in care and repair. Hoisting and haulage ropes, cage repairs, and replacement; safety devices, guides, and sheaves.

(b) Care and maintenance of motors. When motor haulage is used, repair parts, and labor of care and repair.

(c) Care and maintenance of pit cars. Labor and material used in keeping pit cars in repair. New cars replacing wrecked or worn-out cars, also additional cars necessary to maintain output by reason of increasing length of haul after mine has reached its contemplated output capacity.

(d) Care and maintenance of livestock; such as harness and stable supplies. Grain and hay, and wages of stable-men and veterinary, clipping and shoeing, etc. New mules replacing killed or worn-out animals should be charged to maintenance of livestock.

3. Conducting transportation. Drivers, boss drivers, motormen, trip riders, couplers, cagers and pushers, oilers (oil and grease) trappers and switch-throwers, jackmen, and that part of hoisting engine-man's wages not charged to maintenance and repairs.

4. Maintenance of way; that is, repairs to roads, cleaning roads, relaying track, new ties, rollers for rope haulage, etc.

Dumping and Tallying—Top cagers, pushers and dumpers, weigh boss. check puller and track weighman.

Preparation—The proportion of power used in operating screens, crushers, elevators, conveyors, picking-tables, spiralizers, loading booms, etc., and the cost of the labor of attendants thereon, such as inspectors, dock bosses, sulphur and slate-pickers, and the labor of disposing of waste, all material and labor involved in the maintenance of repairs and replacements of such apparatus as is used in the preparation of coal.

If a washer is operated, such investment and its operation should stand by itself. The washer should be charged with the expense of operation, repairs, maintenance, insurance, and its proper depreciation, with the value of the raw coal passed through it, either at cost of production, or, preferably,

at the market value obtainable for raw coal, and credited with the out-turn of washed product.

If the result is a credit balance, it should be taken into operating income as net income from washer; if it results in a debit balance, it should be deducted from operating income as loss on washer operations.

Railroad Car Loading and Yard Expense—To this sub-division should be charged wages, of yard boss, car cleaners, trimmers, car riders, car haulers, brakemen, and all material and supplies used by them.

The expense of maintaining and operating mine tracks, if a switch engine is employed, or if switching is done by the railroad for which a special charge is made, distinct from the freight rate, the expense thereof should be charged to this sub-division.

Power—The generation and transmission of power is about the only expense about a coal mine that is not in total directly chargeable to some one sub-division of operating work. To it should be charged the wages of firemen, fuel-men, ash-haulers, water-men, pump-men, generator and compressor attendants, and such part of hoisting engine-man's and electrician's time, or other labor and material, as may be employed in the care, repair and maintenance of boilers, pumps, engines, generators, air-compressors or other power-generating machinery; wire and pipe used in transmission-lines, cost of water supply and all coal consumed, preferably at its market-value. The cost of coal to the operator for his own consumption is what he could get for it in the market. If an unmerchantable product is used under the boilers, it should be charged at its cost of production. If cost of fuel is not included in cost of power, the accounts do not exhibit true cost. The true cost should be before the operate to induce him to estimate the possibilities of effecting savings by improving his plant or boiler room practice; also to estimate the possibility of effecting economy by purchasing power of outside service companies, or through establishing central power plants. The tonnage consumed per annum under new boilers by large producers is very large, and the cost thereof should be clearly shown.

If outside power is purchased, it should be charged to Power.

Distribution of Power Costs

The expense of power should then be distributed to the different sub-divisions of Operating Expense, in accordance with the proportion of power employed in each section of the work.

Mining, under the sub-division Undercutting, should be charged with the proportion of power applied to machine operation.

Haulage and Hoisting should be charged under Generation and Transmission of Power, with its proportion of power-house expense, as represents the power used by hoisting engines and haulage engines and motors.

Under the sub-division Preparation should be charged the power used for shaker-screens, picking tables, etc.

Ventilation should be charged with the share of expense of power-house, in accordance with the power used for driving fans.

Drainage, with the proper proportion of power used in pumping water from the mine.

The above suggestion that the expense of power should be distributed to the various sub-divisions of the work may appear difficult to the accountant, and in small operations such distribution may be a needless refinement; and in such cases power may well be shown as an undistributed item of operating expense.

However, in large operations, the cost of power is a large item, and the making up of a heat and steam balance will not be difficult to the well-informed engineer or electrician.

The measurement of fuel and water and steam generation compared with the useful work being done, will prove fruitful in results. Such time and effort is well spent, as it leads to the detection of steam line leakages, engine cylinders and valves in bad condition, insufficient power circuits, bad track bonding, etc. The coal operator who wastes coal by overlooking preventable losses is like the merchant who consumes his own stock.

In his lucid and valuable book entitled 'Preventing Losses in Factory Power Plants,' David Moffat Myers well says:

"Just as the expert accountant is able to analyze the expenditure of one hundred dollars in a business enterprise and to show where some of them are wasted or mis-spent, and finally to strike a true balance between income and expenditure, just as truly and with as great a degree of accuracy a trained engineer may analyze and balance the expenditure of energy from the original one hundred per cent income or input, to the final machine horsepower hours of useful work, and in so doing he may point out where certain portions of this energy are mis-spent or wasted, and how they may be saved and converted into useful work.

"There does not exist a power problem that is not capable of solution by the intelligent application of these principles of analysis."

Repairs to Buildings and Structures—To this item should be charged labor and material used in repairs of permanent buildings and structures of the surface mining plant.

Sundries—Small and unimportant items of expense not easily distributable to the above sub-divisions of Expense.

Necessity of Contingent Reserve

In the case of permanent enterprises, the funds derived from charges to operating cost to cover depreciation and depletion are to replace plant and equipment becoming worn out or obsolete; but in coal mining or other wasting enterprises, the purpose of such fund is to replace and redeem the capital invested in the wasting assets, and such duty of redemption fully taxes the allowable charge for depletion and depreciation.

As a general rule, the buildings and major items of plant and equipment placed at a coal mine are calculated to last, and, with proper care and repair, do last the life of the mine, and therefore obsolescence of coal mine plant and equipment results more often from accident than by installation of new appliances. Depletion and depreciation are items of prime cost which can be measured with reasonable exactness and properly provided for by charges to current expense of operation; but coal mining is a hazardous business, and in some regions extra hazardous, and obsolescence being a contin-

gency, common prudence dictates, in order to avoid possible financial embarrassment, that there should be periodically reserved and built up from net income sufficient provision to meet any probable contingency. Such reserve is not an item of current cost, and therefore not deductible in determining taxable income, but the cost upon the realization of the contingency is a proper charge to current expense, and should then be so charged, and not be charged to contingent reserve.

The increase in current expense, by reason of such happening, will reduce current net income, and therefore a corresponding amount, or as much thereof as may be possible should be transferred from contingent reserve to Profit and Loss.

The general conditions existing, and the experience of any mine or mining region, will dictate to the operator the necessary provision for contingencies.

Though maintenance expense is practically a constant factor of current expense in coal mining, prudence also suggests in accordance with the peculiarities of each case the segregation from income of a maintenance reserve.

Balance-Sheet

This should show the exact details of the financial condition of the business and be, at the same time, an historical narrative of the enterprise. The value of the balance-sheet will be in exact measure of the time spent on its production and consideration. The more put into a balance-sheet, the more can be got out of it.

[A suggestion as to a pro forma balance-sheet was submitted by Mr. Brewster, but this has been omitted.]

Bookkeeping

In the foregoing, the principles of accounting have been touched upon, and it is unnecessary to write a treatise on bookkeeping, but it may be useful to refer to the main books required and to comment upon the action of the various operating accounts. The principal books of account are: General Ledger, Cash Book, Journal, Voucher Register, Sales Register, Coal Customers' Ledger.

The Ledger, Cash Book, and Journal need no comment.

Voucher Register—To avoid a multiplicity of ledger accounts, with miscellaneous creditors from whom material and supplies are purchased, the adoption of the voucher system is recommended. The Voucher Register appropriately ruled, both horizontally and perpendicularly to allow the entry of number, name of payee, what for, date paid, and the distribution under the different headings of the amount thereof to the account or accounts to which the items covered by the voucher are chargeable. At the end of each month the total footing should be credited to vouchers payable, and the footings of the various distribution columns charged to the respective accounts. Some accountants post to the General Ledger direct from the Voucher Register, but we recommend a journal entry and posting from the Journal.

Every cash disbursement should be represented by a voucher, and charged on the Cash Book to vouchers payable, with entry of the number of the voucher and name of the payee.

Payments should be checked from the Cash Book into the when-paid column of the Voucher Register; thus the controlling account in the General Ledger covering miscellaneous creditors will be vouchers payable, and the General Ledger balance of this account will agree with the total of an abstract of unpaid vouchers drawn from the Voucher Register.

Sales Register—In cases where coal is consigned through from the mine, a convenient form of Sales Register page is a manifest of billing with columns on the right-hand side, for the entry at general office of price and extension of amount, these pages to be carried in a loose-leaf binder until the end of the year, when they should be permanently bound.

The amount of each invoice should be posted from the sales sheet to the debit of the customer's account in the Coal Customers' Ledger. At the end of the month the total should be taken up in a journal entry, charging coal customers and crediting the coal sales account of the mine from which the coal is shipped.

As payments are received from coal customers, they should be credited to coal customers in the Cash Book. Names with

the amounts paid by each customer entered in "short." From the Cash Book should be posted the "shorts" to the individual accounts in the Coal Customers' Ledger; thus the controlling account in the General Ledger representing amounts due from coal customers will be coal customers, and the total balance of individual accounts in the Coal Customers' Ledger will support the balance in the General Ledger.

Revenue Accounts

Coal Sales—A coal-sales account with each mine to be credited with the invoice value of coal sales, as per Sales Register. To this account should be charged any freights prepaid and included in the invoice price, and any allowances and adjustments, and this account closed out monthly to the credit of Operating Account of the mine from which the coal is shipped.

Rent of Dwellings—These are credited with rents received; charged with the care, painting and repairs, taxes, insurance and depreciation; and are closed out monthly to the credit of Operating Account for the mine to which the houses belong.

Farming Operations are credited with the value of crops, timber cut, rents, if rented, etc.; and charged with labor and supplies, repairs to machinery and buildings, small implements, fertilizer, etc., taxes, insurances and depreciation. If the farm property is identified with a particular mine, close out to the credit of the Operating Account of said mine; or if not identified with a particular mine, close out to income account.

Washer Operating Account is credited with the proceeds of raw coal sent to the washer, labor and supplies, repairs to buildings and machinery, small tools, water-supply expense, taxes, insurance, and depreciation. If identified with a particular mine, close out each month to debit or credit of Operating Account of said mine. If a central washer plant, close out to Income Account.

Coke-Plant Operations are credited with proceeds of coke sold; and charged with value of raw coal sent to coke plant, labor in and about plant, repairs, material and supplies, small tools, taxes, insurance on, and depreciation of buildings. If identified with a particular mine, close out to Operating Ac-

count of said mine. If a central plant, close out to Income Account.

Mercantile Operations—If the store is identified with a particular mine, results of the store business should be closed out to the Income Account of such mine. If not identified with a particular mine, the results of the store business should be carried to Income Account.

Expense Accounts

General Expense is charged with the salaries and expenses of officers; directors' fees, legal expense, general office rent, books, stationery, telephone and telegraph; all other expenses of administration and maintaining corporate existence.

Close out by charging to the Operating Account of each mine with such mine's just proportion. This is generally prorated in accordance with the tonnage furnished by each mine.

Selling Expense—All expenses connected with the promotion and making of coal sales; advertising; salesmen's salaries as are dedicated to the selling department; books; stationery; printing; postage; telephone and telegraph; office rent; billing and collecting of coal customers' accounts.

Close out by charging to the Operating Account of each mine its proper proportion, usually based on tonnage derived from each mine.

Material and Supplies.—Vouchers covering purchases of material and supplies immediately used may be distributed direct to the debit of operating expense, but appropriate Material and Supplies Accounts should be kept of such materials as are carried in stock. For example, in many localities the purchase of props, cross-bars, and caps depends upon the season of the year, and not in accordance with current consumption, and in such cases a Mine Timber Account should be opened, to which should be charged the cost of timber, including freight and the cost of unloading and handling at the mine. As the timber is taken below it should be credited to Timber Account and charged to Operating Expense, with the expense of preparing and delivering to the working face under the sub-division Timbering.

The purchase of rails, fastenings, spikes, and ties for track-laying is always in anticipation of future requirements, and a Track Material Account should be opened, to which the cost of all such material should be charged, and as such material is taken below it should be credited to Track Material Account and charged to Operating Expense under the sub-division Track Laying.

The same may be suggested as to mining machine repair parts, but in operations where five or more mining machines are used, it will be found that there is little variation in the expense per ton for machine supplies from month to month, and so far as the general accounts are concerned, unless large stocks are carried, it will be proper to charge such supplies direct to Operating Expense, and adjust at the end of the year by comparison of the inventory at the beginning and end of the year.

Mine Operating Expense—An account with each mine to which will be charged all expenses for labor and material used in and about the mine, classified in accordance with the different accounts of work done, as recommended.

Close out by charging to Operating Account of the same mine.

Operating Account—An account with each mine to which will be credited the net realization of coal at the mine; other income belonging to such property.

Charge proportion of general expense; proportion of selling expense; transfer of operating expense; royalties; depreciation and depletion; general insurance, liability or compensation insurance; taxes, excluding income and war taxes.

Close out by transferring to Income Account.

Income Account—To be credited or charged with balance of Operating Account of each mine, results of coke plant; results of washer operation; interest received or accrued; all other income received or accrued.

Charge with contingent reserve; maintenance reserve; or other reserves; income and excess profits tax; interest paid or accrued.

Close out to Profit and Loss at end of the year.

Profit and Loss is credited or charged at end of year with transfer of balance of Income Account, and charged with dividends paid. The balance of this account to rest as profits applicable to dividends, and chargeable with the transfer of such amount as it is desired to transfer to permanent surplus.

Conclusion

In submitting the foregoing suggestions as to a standard system of accounting and analysis of cost of production, we fully appreciate that many operators have highly developed systems with which they are fully justified in being well satisfied, but we are sure that the advantages of uniformity of practice will appeal to them.

The many whose accounting methods leave much to be desired will derive the most benefit from adopting a proper system. They will know better how they stand, what they must have to cover their requirements, and proper accounting will help them to exercise the tenacity and perseverance requisite for the salvation of their capital and to win a proper return thereon.

An accounting system will not run itself, nor in itself reduce costs, nor increase efficiency; this is up to the operator himself; he must study and compare, vitalize the figures, and act on the facts they illuminate.

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